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Mitosis in Higher Plants.
(With Short Notes on Technique.)

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INTRODUCTION.

THE present investigation was undertaken with the view of determining stage by stage the exact structural changes undergone during mitotic division by the chromatin and other elements entering into the composition of the nucleus in the Higher Plants and also to verify the comparatively recent discovery, viz., the absence of the centrosome, or at least of any formed structure comparable to the centrosome found in cells of the lower plants (Hepaticae, Fungi) and in most, if not all, animal cells.

The drawings illustrating the text have mostly been taken from photo-micrographs under the 1/6' Leitz Objective, with an ordinary ocular: exposures for the photographs varied with the actinic power of the stains used in the staining of the sections, but incidentally I have found that Safranin-stained sections have given the best and clearest results.

I have deemed it most satisfactory in the majority of cases to make drawings from *photographs*, as there will then be no question as to the presence or absence of any given structure; different investigators interpret various structures seen under a microscope, in their own manner, and are apt to introduce a personal equation into drawings: for instance, some years since, one investigator figured centrosomes in drawings of the mitotic phases occurring in pollen-mother-cells of the Lily, but these structures are apparently not present according to later and more detailed research. A few photo-micrographs have, however, been introduced.

The stages in Mitosis, or indirect nuclear division, in the Higher Plants have been of recent years fairly accurately made out, but there are one or two points, which I shall touch upon incidentally, requiring a little fuller elucidation, viz., the exact stage at which splitting of the spireme (or separate chromatin-granules) occurs, and the first appearance of the nuclear spindle. These two points are well determined in many animal cells, but seem a little vague in the case of some of the Higher Plants.

SECTION I.

Summary: Material selected; modes of fixing, hardening, sectioning, and staining.

After a preliminary trial of various root-tips and young rapidly growing tissues, it was decided to select the following material for study:—

Root-tips of Allium (water-cultures).
Root-tips of Hyacinth (water-cultures).
Embryo-sac of Lilium Martagon (prefertilisation stages).
Axis of young female Cone of Larix Europæa.
Endosperm of Caltha palustris (early divisions).
Endosperm of Helleborus niger.

Root-tips of Fritillaria were tried, but it was found that the protoplasm contained granules staining with osmic acid, and so was unsuited for fixing with Flemming's solution. The root-tip of Nymphæa was also used.

The clearest figures were obtained from cells of the root-tip of Allium; the largest from the embryo-sac of Lilium and root-tip of Hyacinth.

FIXING.

Root-tips were fixed by immersing them in a modification of Flemming's solution, viz.:—

Osmic Acid, 2%	... 10 c.c.
Chromic Acid, 10 %	... 4 c.c.
Glacial Acetic Acid	... 3 c.c.
Distilled Water ...	... 20 c.c.

This solution was occasionally strengthened by the addition of rather more osmic acid, as this component ensures good fixing when we are dealing with rapidly dividing cells.

Tissues were left in this for about 12-24 hours, then transferred to distilled water and washed for 12 hours: they were then hardened in increasing strengths of alcohol, viz., 70 per cent., 80 per cent., 90 per cent., and finally absolute alcohol. After this they were transferred to methylated spirit. Sections were cut with a razor *by hand* in split pith; this is important, as root-tips give far better results when not cut too thin, and, moreover, the processes of embedding in paraffin and subsequent removal of that substance by xylol seem in plants to deteriorate the final results. It was found fairly easy to cut sections of roots in pith considerably less than half a cell thick. By this method I have been able to preserve the exact relationship between chromatic and achromatic structures in the nucleus.

STAINING.

The stains mostly used were, Safranin (aqueous solution), gentian violet (aqueous), methyl green (acetic), haematoxylin (Böhmer's, Delafield's, Ehrlich), orange-green and vesuvine. These were used alone or in combination, the most successful compound stain for nuclei in root-tips being the well-known gentian-violet-safranin-orange-G method. But safranin alone gave excellent results with the nuclei in cells of the root-tip of Allium. If compound stains were used they were employed separately in rather dilute solution, and the sections were washed in distilled water after each. After staining, sections were dehydrated and mounted in Canada balsam in the usual manner, using oil of cloves for the clearing process.

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Recording of observations, as was mentioned above, was obtained chiefly by the photographic method* ; the exposures varied from 5 minutes to 30 minutes, according to the objective and ocular used, and the plates employed were usually those known as Ilford Rapid Isochromatic (backed plates). These were found to give results far superior to the Ordinary or Rapid plates, as the backing eliminates a certain amount of "halation," a factor which in the ordinary plates causes much irregular dispersion and fogs the image.

SECTION II.

Summary: The quiescent cell. Preparatory phases in mitosis. Presence or absence of centrosomes.

The nucleus of the quiescent cell in root-tips of Allium and Hyacinth lies in the geometrical centre of that cell, is spheroidal in shape, in rectangular cells the long axis of the nucleus corresponding with that axis of the cell which passes through the centres of the two end-walls. This relative position I believe to be invariable, although at times we see mitotic figures, which, through some mechanical distortion, have become somewhat displaced, and lie with the axis of the spindle diagonally placed.

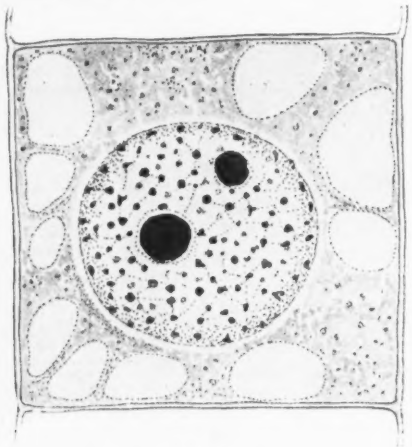

Fig. 1.

A single cell from the root-tip of Allium, showing cell-wall, cytoplasm, and central nucleus. The latter shows externally a nuclear membrane, and internally granules of chromatin arranged at intervals upon a network of linin, with two nucleoli. The clearer part of the nucleus is the nuclear plasm in which these other structures are suspended.

In ultimate structure we can determine in each quiescent nucleus the clear unstained portion (nucleohyaloplasm) and the stained chromatin granules, with, as a rule, one or two, perhaps more, true nucleoli (plasmosomes). It is not common to find Karyosomes (net-knots) in really quiescent nuclei, for, as a rule, the chromatin granules are distinct, small, highly refractile granules, having on the whole a spheroidal shape. Faint connecting lines, presumably those of the linin network, may be seen amongst the granules in a good preparation, and at the outer boundary of the nucleus a clear narrow zone distinct from the general cytoplasm, which has been said to represent the clearer kinoplasm. It is, however, extremely doubtful in many cases whether this kinoplasm exists, for very slight shrinkage during fixation and hardening will produce the same optical appearance.* The nucleoli are often surrounded by a clear zone due to shrinkage of the nucleohyaloplasm, but in good specimens this is reduced to a minimum (see Figs. 1, 2, and 3).

From the results of recent research it appears probable that the kinoplasm may be considered absent in

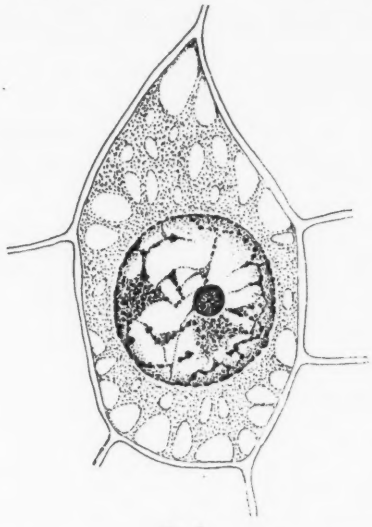

Fig. 2.

A pollen mother-cell from a developing anther of Polygonatum; the large spheroidal nucleus shows numerous "net-knots" of chromatin and traces of a linin network.

most cells, and that a very delicate cytoplasmic membrane is present which, to a certain extent, shuts off the nuclear structures from the cytoplasmic mass, although, as Campbell has shown, delicate linin connections appear to penetrate this membrane, and even the cytoplasm and cell-wall, and pass from the nucleus

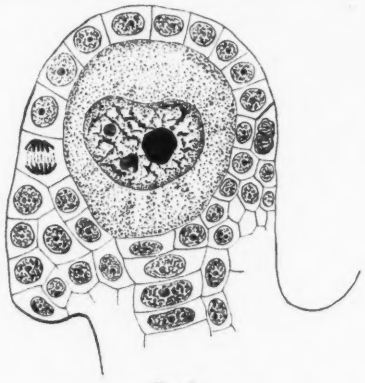

Fig. 3.

The young embryo-sac of Lilium surrounded by cells of the rudimentary nucellus. The large nucleus shows net-knots of chromatin and three nucleoli.

of one cell to those of adjacent ones. In fact, there would seem to be an intimate inter-nuclear communication, which, however, my preparations do not show. What influence, if any, this intercommunication may have upon the mitotic process is at present undetermined, but it is fair to suppose that stimuli may be transmitted along these lines of communication, and

* I have drawn some of the figures from personal observation under the 1/12' oil immersion objective, as the photographs were very difficult to obtain.

* It would be of extreme value to cytologists if an "isotonic" fixing reagent were prepared; the author does not know whether any such exists.

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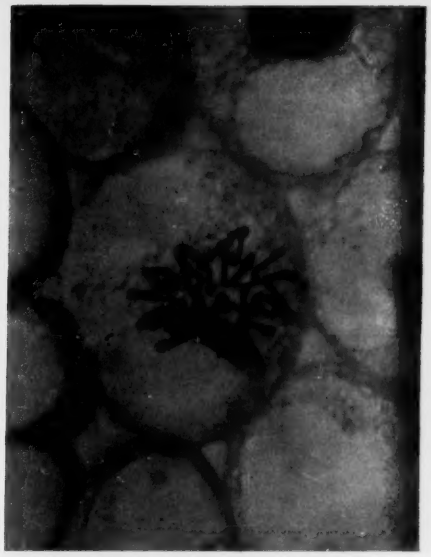
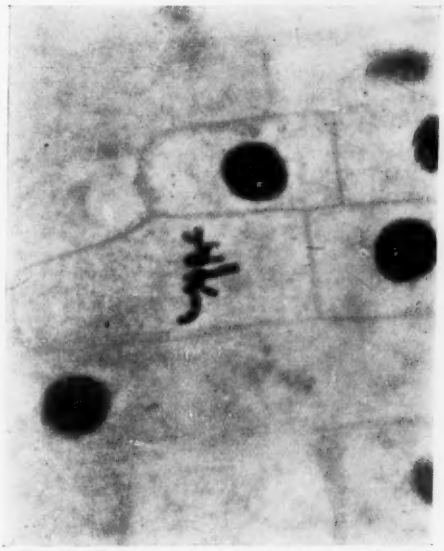
I.—The embryo-sac of Lilium showing the nucleus at the stage where the Primary Chromosomes have just been formed: each chromosome is longitudinally split and twisted.

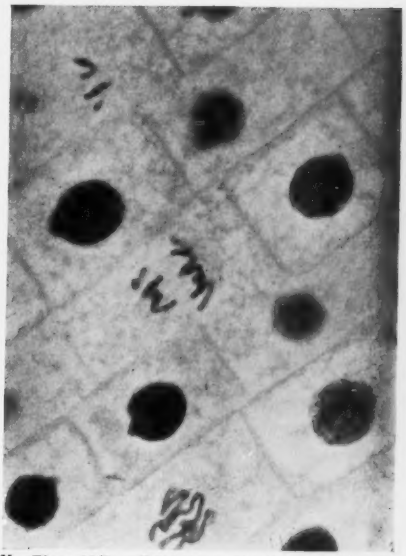


II.—The Monaster stage from a cell of the root-tip of Hyacinthus seen in a transverse section.



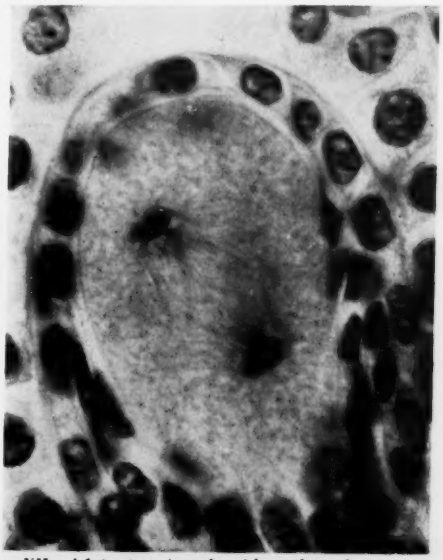
III.—The Monaster stage from the side (root-tip of Allium).

IV.—A stage (upper cell) where the secondary chromosomes are just separating from one another. Note the mantle-fibres of the achromatic spindle. A later stage is seen in another cell.



V.—The middle cell shows a metaphase position of the daughter-loops. Below is seen a late spireme.

VI.—An oil-immersion ($\frac{1}{12}$') photograph of the same figure as in V.



VII.—A late stage (anaphase) from the embryo-sac of Lilium. Note the amphiaster.

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that the mitotic process in any one cell may be controlled to a certain extent by a similar process occurring in adjacent cells.

PREPARATORY STAGES.

The earliest change to be observed in the nucleus when mitosis is starting is the somewhat deeper staining of the chromatin granules, and an arrangement of these into definite lines with as yet distinct spaces

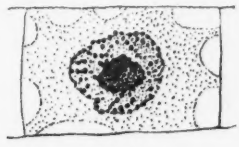

Fig. 4.

An early stage in mitosis in a cell of Allium root-tip; the chromatin granules are becoming arranged into definite lines upon the linin thread.

between the individual granules (see Figs. 4, 5, and 6). The nucleoli still stain deeply, but seem less regular in contour; these gradually, during the next few stages, become either absorbed, or possibly help to form fresh nuclein for the chromatin elements. [It is a moot point as to whether paranuclein, the constituent of nucleoli, can be transformed into nuclein, and, judging

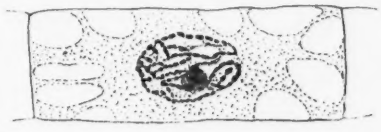

Fig. 5.

A slightly later phase in the formation of the spireme (Allium).

from the length of time one can detect the nucleoli, viz., right on into the late spireme stage, it might appear doubtful; yet some observers state that this chemical change is possible, and that the nucleoli form a sort of reserve-material for the formation of fresh chromatin.]

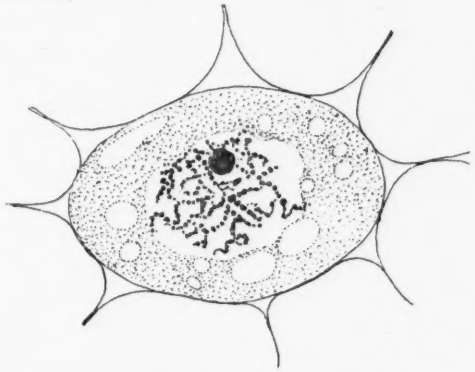

Fig. 6.

A cell from root-tip of Hyacinthus, showing an early stage in the formation of the spireme. One nucleolus is seen.

From certain staining peculiarities, however, it would seem that, during the spireme stage, the nucleolar substance becomes more and more allied to chromatin; with safranin, the tint of staining is the same, and with gentian-violet the nucleoli, which, during the quiescent period, stain a red tint, during the later stages take on a much deeper purple colour; in fact, appear much the same in tint as the chromosomes. It would, therefore, appear probable that a substance so allied to nuclein should, by an easy chemical change, become transformed into that material.

The deeply staining chromatin granules soon become arranged into a line, the intermediate spaces becoming smaller and smaller, and finally they appear to fuse, so as to form a skein-like band of chromatin lying within the confines of the nucleus; whilst this process has been going on the well-defined contour of the nucleus is gradually lost, and the skein appears in section to lie in a clear homogeneous portion which corresponds to the former nucleohyaloplasm, although I believe this is, during earlier stages, considerably modified. I have not been able to detect any bodies comparable to centrosomes in or at the edges of this clear portion and the so-called astral rays, so obvious in preparations of animal cells are seemingly absent. In the embryo-sac of Lilium martagon at the end of the first division we have a well-defined nuclear spindle between the two daughter-nuclei, but beyond these there is no evidence of the existence of astral rays; the preparation would certainly show them if they were present, as the achromatic fibrils are clearly defined.

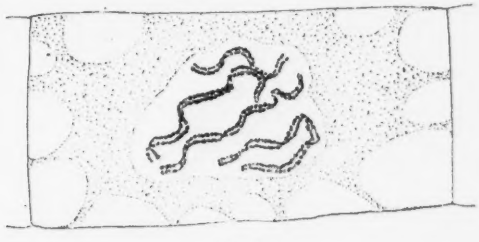

Fig. 7.

A cell from Allium root-tip showing portion of a spireme. The granules of the earlier phases have divided so as to form two parallel bands of chromatin.

[The achromatic spindle cannot in Allium, Hyacinth, or Lilium be detected during the early or later spireme stages; in lower plants, such as Erysiphe (Fungi), according to Harper, an intranuclear spindle is formed in the early stages with distinct astral rays at the poles. In fact, as we shall see later, it is probable that in the absence of centrosomes or allied structures the amphiaster is only formed as a rather late structure, and seems, moreover, to be produced by the origin in the clear nucleohyaloplasm of lines of condensation, the outermost being of a firmer and more contractile nature (mantle-fibres), and the innermost or axial fibres being looser in texture and non-contractile.*

In good preparations one may detect at each pole of the spindle a spot which is more refractile than the other parts, but this is probably only an optical effect due to the aggregation at these points of the numerous converging spindle-fibres. But of this later.]

SECTION III.

Summary: The Spireme stage: General configuration of the skein, and probable factors in this arrangement: Origin of the primary chromosomes.

It is easy to trace the stages which lead to the complete spireme figure, from the time when the chromatin granules are distinct separate dots to that phase when no spaces can be distinguished and the granules have

* See Wilson: "The Cell in Inheritance and Development."

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apparently fused* to form the skein. In Allium these changes may be best made out by staining sections with safranin alone, and well washing out any excess of stain; in this way beautiful preparations may be obtained and the utmost clearness prevails, since the protoplasm and other cell-structures remain quite unstained, the contrast being very sharp (see Figs. 8, 9, 10, and 11). As a rule nucleoli may be detected almost to the end of the spireme stage, but their contour becomes more and more irregular, suggesting either absorption from the periphery inwards, or, perhaps, conversion into a soluble substance to start with, with subsequent reconversion into chromatic substance (see *supra*). In the figure above referred to a clear zone

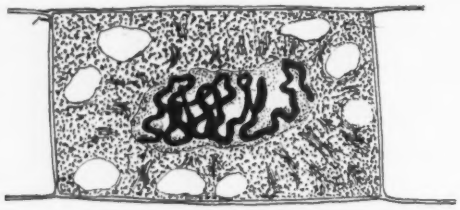

Fig. 8.

Portion of a complete spireme from root-tip of Hyacinthus. The longitudinal fission is not apparent.

can be detected just outside the nucleus, but this is probably due to an optical effect, owing to a mean focus having been taken, or, possibly, to slight shrinkage, as the cytoplasm seems to end at the outer boundary of that zone.

In many cells the chromatin band takes on a marked wavy outline, apart from the general skein-like arrangement (see Fig. 9). This is more obvious in elongated nuclei where several parallel lines of these wavy bands may occasionally be seen; this arrangement must result in great economy of space, where in so small a volume as the nucleus a large amount of extra chromatin has to be accommodated. It will also often be noticed that the general trend of the fibrillæ of the spireme is in the direction of the long axis of the

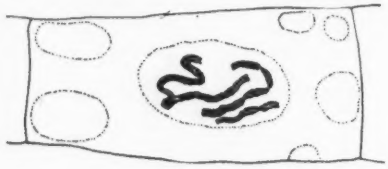

Fig. 9.

Portion of a spireme showing the resolution into two bands of chromatin (1/12′ oil-immersion drawing).

nucleus; this arrangement is, however, occasionally reversed, and the coils pass transversely at right angles to the long axis, and in other cases again the conformation is quite irregular.

The skein appears to be suspended in the nucleo-hyaloplasm throughout its whole extent, and not merely line the outer boundary; the consistency of the clear nuclear sap seems to be such that at no period of mitosis does it hinder the movements of the chromatin elements, but later, as we shall see, when the achromatic spindle arises, forces come into play which exert a marked guiding or pulling action upon the chromosomes, this taking place along lines of greater condensation than prevail in the hyaloplasm of the earlier stages.

Relative to the axes of the nucleus, there is as yet at this stage no definite orientation of the chromatic band, but at a somewhat later stage, viz., just subsequent to the origin of the primary chromosomes, there is in some instances a definite arrangement of the split spireme transversely to the long axis of the rudimentary achromatic spindle. It is somewhat difficult to determine whether this orientation occurs prior to or after the formation of the primary chromosomes by the breaking up of the spireme, but we shall refer again to this later on. The spireme persists for some little time; in fact,

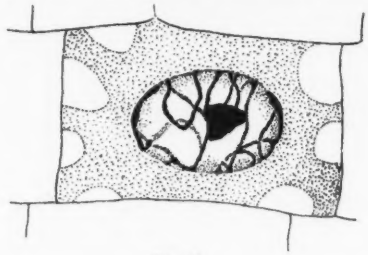

Fig. 10.

A nearly complete spireme from root-tip of Allium (drawn from a photo-micrograph).

until all traces of nucleoli have vanished, when the phase may be said to be complete.

Under high powers of the microscope (1/12′, 1/10′ oil immersion objectives) the chromatic band may be resolved into two extremely delicate bands composed of chromatin-granules set very close together upon two adjacent threads of linin. These bands lie parallel to one another, and so closely together that lower powers (1/6′ or 1/8′) are not sufficient to resolve them (see Fig. 9). In earlier stages of the spireme two parallel lines of chromatin granules can often be detected, showing that the original chromatin granules undergo fission at an early period (see Fig. 7). As increase in mass of

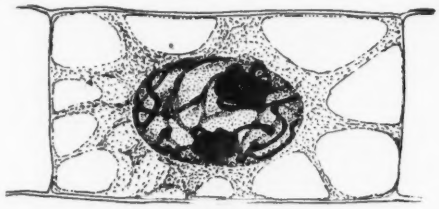

Fig. 11.

A spireme from root-tip of Allium (drawn from a photo-micrograph).

the chromatin proceeds it becomes somewhat difficult to resolve the band into its double nature, as the granules approach one another laterally as well as in the longitudinal directions* (see, however, Fig. 14).

It is somewhat difficult to determine the factors which cause these movements, and changes in mass of the chromatin, ultimately producing the skein-figure; the movements take place most probably along the linin network, but the chemistry of the process is as yet obscure. The chemical changes occurring must be important, for comparison between the mass of the

* Exact fusion probably does not occur, but with very high resolving powers of the microscope the granules may be made out as distinct even in the spireme stage. (See *infra*.)

* In Fritillaria, according to Flemming, the chromatin thread in the early nuclei of the endosperm, seems to be split both transversely and longitudinally at the end of the spireme stage. This I have verified in Allium and Hyacinthus; in fact one can trace the double nature of the spireme back to the granule stage. The linin-thread also shares in the fission.

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chromatin at the beginning and end of the process shows that a great increase takes place, and, moreover, a relative increase in the staining capacity. By some investigators the nucleus, even in the quiescent period, has been looked upon as a centre of cell-activity for albuminous substances, and during the mitotic process, certainly, there are many reasons for the assumption of greatly increased metabolism in this structure. But the ultimate chemical changes undergone by the chromatin, paranuclein and hyaloplasm are as yet too obscure to be more than mere speculations. Staining re-actions give us a certain amount of insight into the various phases of the process*, but the ultimate causes of the regular movements performed by the chromatin must still be matter for investigation.

ORIGIN OF THE PRIMARY CHROMOSOMES.

At the close of the spireme stage we find that there is usually a short period during which no further change occurs, and then the next phase entered upon is the one where transverse fission occurs at several points on the chromatin thread, this resulting in the production of a definite number of primary chromosomes, each

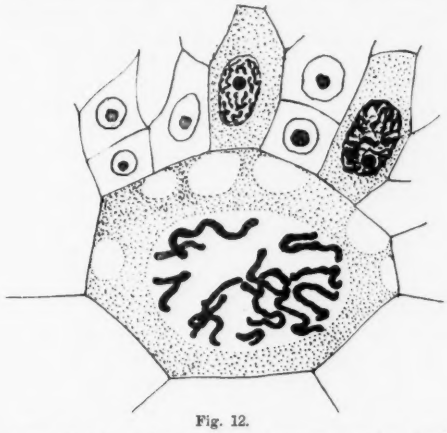


Fig. 12.

A cell from root-tip of Hyacinthus in transverse section showing the stage where the spireme has just broken up into the primary chromosomes. The longitudinal fission is not apparent.

chromosome being a double structure (see Fig. 14), this number being constant for a given species or family. After numerous observations I have concluded that in Hyacinthus this number is twelve (or twenty-four), in Allium probably eight (see Fig. 12).

It seems that the formation of the primary chromosomes occurs before any orientation takes place, but in many cases it is difficult to determine whether the intervals seen in the original spireme are not due to mechanical rupture ; however, after examining a large number of spiremes at the end of that phase I have come to the conclusion that the fissions leading to the production of the separate primary chromosomes occur whilst the main trend of the chromatin band is in the direction of the longest axis of the nucleus (or cell), and before the appearance of any trace of the achromatic spindle fibres. Subsequent to this we get orientation of the chromosomes, so that shortly after their separate individuality they come to lie in somewhat irregular positions, but with a tendency to lie in a plane transverse to the longer axis of the cell. About this time also we find evident traces of the fibrils of the achromatic spindle, for it is by the agency of the mantle-fibres of that spindle that the primary chromosomes are either pulled or guided into their equatorial position.

The transverse fissions that occur in the spireme are equi-distant and divide the band up into parts of exactly equal length, although in sections these seem to be somewhat unequal at times, owing to mechanical disturbance during the cutting of the section ; usually each primary chromosome is at first somewhat bent and

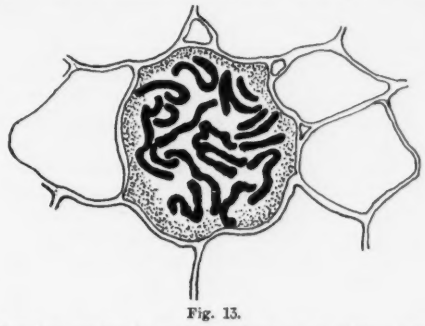


Fig. 13.

The phase just previous to the arrangement of the primary chromosomes into an equatorial plate (from a transverse section).

irregularly twisted, but when the monaster stage is reached each chromosome comes to lie in the equatorial plane and has a shape somewhat like that of the letter U or V. Modifications of this shape occur in some cases ; for instance, in Picea, where later on during maturation stages in the embryo-sac heterotypical divisions occur, as evidenced by the formation of rings instead of V's or U's in the monaster stage.* In some cases also an X-shaped chromosome may arise or one

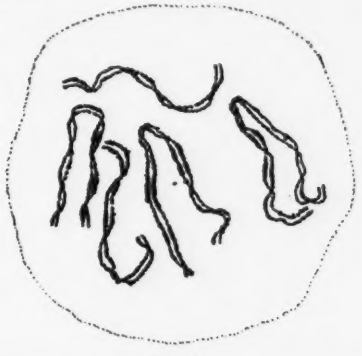


Fig. 14.

A nucleus from root-tip of Hyacinthus at the time when the spireme has just broken up into primary chromosomes. Each chromosome (only a few drawn) is seen to be longitudinally split.

in the form of a Y. From my own observations, however, I find that the forms occurring in Hyacinthus and Allium during vegetative divisions conform to the usual type, but we shall return to this later on.

The question now arises, What is the ultimate causation of this transverse division of the spireme into a number of equal chromosomes? The factors entering into this causation are obscure, but it is obvious that at certain points on the spireme there is either a chemi-

* It has been shown that these staining re-actions point to a definite chemical combination of chromatin and the stain and not a mere mechanical process.

* See Wilson, "The Cell in Inheritance and Development." These aberrant shapes occur often in the reduction divisions of higher plants, but the subject is one of extreme complexity.

cal absorpion of chromatin, or else an abrupt mechanical rupture produced by conditions which are as yet undetermined.

In the nuclei of gland-cells of Chironomus (Insecta), to refer to the animal cell for comparison, we find the spireme composed of a large number of discs of chromatin, and by this arrangement the mechanical fission between two discs would seem a ready explanation; in plant-cells also the same disc-like appearance has been seen, notably in Fritillaria endosperm nuclei. In Helleborus foetidus, Mottier has shown that the chromatin-granules apparently do not fuse completely, but that even up to the time of longitudinal fission of the primary chromosomes they remain distinct, and each one splits later on in the long axis of the chromosome.* The true explanation would seem to involve more than a mere chemical hypothesis, for we cannot assume that there are, at certain equi-distant points on the spireme, or even in the vicinity of these points, chemical substances acting as transformers or absorbers of chromatin. The question appears to me to involve the problem of heredity, or the retention of impressed characteristics handed down from the time when mitosis first had its origin in the cell. I do not think that the phenomenon can be explained simply on chemical or physical lines; moreover, if, as certain investigators have shown, the maternal and paternal chromatin retain their individuality beyond the second or later divisions of the fertilised egg-nucleus, we have here a possibility of the occurrence of heredity manifestations.

(*To be continued.*)

The Earliest Eclipse.

IN a lecture on "Chinese Astronomy,' published in the Journal of the British Astronomical Association, Mr. E. B. Knobel mentioned an eclipse which has hitherto escaped record. It is noticed in a Chinese book called "The She King," a work consisting entirely of poems, and it was recorded in Part II. of Book IV.

I.

At the conjunction (of the Sun and Moon), in the tenth month,
On the first day of the Moon, which was Sin-Maou,
The Sun was eclipsed—
A thing of very evil omen.
Then the Moon became small.
And now the Sun became small.
Henceforth the lower people
Will be in a very deplorable case.

II.

The Sun and Moon announce evil
Not keeping to their proper paths.
All through the kingdom there is no (proper) government,
Because the good are not employed.
For the Moon to be eclipsed
Is but an ordinary matter.
Now that the Sun has been eclipsed,
How bad it is!

This eclipse occurred on the very day and month assigned to it in the text, which had been verified as August 29, B.C. 775. This was the earliest date in history of any sort which had been confirmed by astronomical calculation.

*Some of my preparations from Allium show distinct chromatin granules well on into the spireme stage. (See Figs. 4, 5, 6, 7.)

The Motion of the Sun and Earth in the Universe.

By F. W. HENKEL, B.A., F.R.A.S.

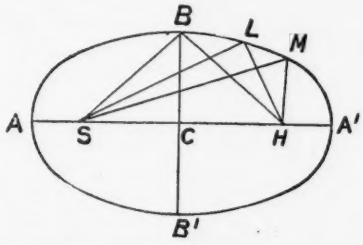
UP to about 350 years ago our earth was considered to be the fixed centre of the Universe. Round it revolved the heavenly bodies "sun, moon, and stars." It is true that Pythagoras and others had imagined a motion of the earth round the "central fire," alleging that fire, being nobler than earth, the former (Sun) and not the latter (Earth) was the centre, and around this the latter moved, but these views had few supporters.

However, Copernicus, in his great work, "De Revolutionibus Orbium Coelestium," published just before his death and for that reason sometimes compared to the "death dirge" of the swan,* showed how much more satisfactorily the apparent motions of the planets could be accounted for, by supposing that they, together with our earth, were in motion round the sun. A diurnal rotation of the earth on an axis also accounts for the phenomena of the rising and setting of the heavenly bodies. The apparent motions of the sun and moon amongst the stars (in the direction opposite to that of the general diurnal motion) could be roughly explained by supposing these bodies to move in paths not greatly differing from circles having the earth not at the centre of these curves, but slightly "excentric" (Latin *ex*, out, *centrum*, the centre). Minor differences were partly accounted for by the system of "epicycles." With the planets Mercury, Venus, Mars, Jupiter, and Saturn (these were all that were known before the invention of the telescope), the case was different. Though their "general" motion is in the same direction as that of the sun and moon, yet at times this is reversed, they move in the opposite direction or are "retrograde," at other times they actually seem to stop or are stationary amongst the stars. These alternate advances and recesses are so evidently connected with their position as regards the sun, that there seems good reason for thinking that the early Egyptian astronomers considered that these five bodies moved round the sun, the latter moving, in its turn, round the earth. When we view a body, such as a distant light moving round a centre, from a point at some distance off, we observe just such changes of motion. At one moment the light seems to be moving to the left, then it stops, and moves to the right, after a time stopping once more, and moving in its former direction, and so on, indefinitely.

When we are ourselves in motion round the same centre we observe exactly the same changes in motion as occur with the planetary motions. Copernicus, accordingly, showed that this apparent complexity was due to the fact that we view their motions, not from a fixed, but from a moving station, and that, consequently, our own motion, of which we are not conscious, is mixed up with that peculiar to each planet. His views, though much opposed on various grounds, gradually gained more supporters, and the invention of the telescope, with the discovery by Kepler of the true laws of planetary motion, led to the universal acceptance of the "Copernican system." Copernicus showed that if the planets Mercury and Venus revolve round the sun in orbits lying within that of the earth, they

* In legend the swan is supposed to burst forth into song just before its death. Copernicus waited till just before his death for the publication of his great work. He was a priest of the Roman Church, and probably feared the condemnation of the "authorities."

must exhibit phases or changes of appearance, like the moon, and though these phases are not to be perceived by the unaided eye, yet he is said to have predicted that they would be seen could our eyes become sharper. Galileo, just 300 years ago, turning his newly-made telescope on the planet Venus, perceived by turns all the various phases, "crescent," "half-moon," "gibbous," and published his discovery in a Latin "anagram," which, being transposed, read "The Mother of Love (Venus) imitates the appearance of Cynthia (the moon)." According to the "Ptolemaic theory," in which the earth is at the centre of the Universe, Venus lies always between us and the supposed orbit of the sun, and, consequently, can never be seen as more than of "half-moon" form. The discovery of the "gibbous" (appearance like that of moon two or three days from full) and "full" phases was, therefore, a strong argument of the truth of Copernicus' theory. Mercury was found in like manner, to show the same phases as Venus. Thus, by the middle of the 17th century the Copernican theory was well established, and few astronomers doubted its general truth, though Kepler showed that the paths of the earth and other planets were not circles as Copernicus supposed, with the sun lying slightly out of the centre, but *ellipses* or oval curves, having the sun, not at the centre, but at a point called the focus. [Geometrically, an ellipse has two foci (S and H in Fig.), and if L and M be any two points on the curve the sum of the lengths S L + L H and S M + M H is always the same, and equal to A A' the longest diameter. The



Ellipse S and H foci, C centre. AA' major axis (longest diameter); BB' minor axis (shortest diameter).

distance of S from C, the centre, is a measure of the "eccentricity" of the ellipse. If S is very near to C the curve is very nearly like a circle, and this is the case with the planets]. It was this circumstance that made it difficult to detect the true form of the planetary paths. However, the planet Mars moves in an ellipse considerably more eccentric than the orbits of most of the other planets, so that it was through the study of its motion that Kepler was led to the discovery of his first law. "Each planet moves in an elliptical orbit round the sun, the latter body being at a *focus* of the ellipse." [The word focus (Latin *focus*, a hearth) comes from the fact that if a source of light or heat be placed at this point and rays fall upon a polished elliptical surface they will all, after reflection, converge so as to meet at the other focus, and, consequently, will ignite any combustible substance placed there.]

After the true laws of planetary motion had been established and our earth reduced to the rank of a planet moving round the sun, having the moon as a secondary body attending it in its motion, the question arose as to the nature and distances of the stars, called, from their maintaining unchanged positions relatively to one another, the fixed stars. Lying beyond the planets, these "landmarks of the Universe" are seen century after century preserving the same configurations, so that were the ancient Greek astronomers able to revisit the scene of their labours they would at once recognise the old familiar constellations. Yet the earth, moving in an orbit round the sun whose diameter is about 186 millions of miles, changes its place continually, and its position now is different from that which it occupied six months ago and will occupy six months hence. "How is it," said those who objected to the Copernican theory, "that all this great change of position does not produce any change in the apparent places of the stars?" When we are in motion on a ship or in a train we observe surrounding objects apparently moving in the opposite direction, the nearer ones changing *their places more quickly* than those which are more distant, and this apparent change is called *parallax*. Yet from all parts of the earth and at all times of the year the stars preserve the same unchanging positions, notwithstanding the rapid motion of the former. All that could be answered to this objection was (and is) that so vast is the distance of even the nearest star that no more effect is produced by this motion than would be produced on the apparent position of a distant steeple if we shift our point of observation by a hair's breadth! With the more refined instruments of modern astronomy *slight* changes of position due to the earth's motion have been detected, but the measurements necessary to detect this are, perhaps, the most delicate of all to be found in the range of exact observation. Sir William Herschel, who, from an accomplished musician, became the most famous astronomer of his day, the discoverer of the planet Uranus, and the first who looked beyond our solar system to the vastnesses of the Milky Way and the "star depths," attempted to detect stellar parallax in the following way:—All over the sky there are found instances where two or more stars are very near to one another, sometime a number are thus situated. Such are known as double, triple, or multiple stars, as the case may be. The members of these vary greatly in brightness, and Sir W. Herschel, supposing (as is sometimes the case) that in the case of a pair of stars seen close together, the fainter one was much further off than the brighter, set to work to measure their angular distances from each other during the course of the year. In such a case the nearer star being more displaced by the earth's motion than the further one, there would be a regular variation in the relative distance and position of the two stars during the course of the year, by means of which an estimate as to the distance from the earth might be made. However, to his surprise, Herschel found, not this, but a regular progressive change showing that one of the stars was describing an orbit around the other, and that they were not merely apparently connected by being in the same direction as seen from the earth, but were really physically connected and members of one system, at about the same distance from us.

Most of the double stars, in all probability, are really "binary" couples revolving round their common "centre of gravity," and several hundreds of such are now *known* to be so. Thus Herschel said: "He went out like Saul to seek his father's asses, and found a kingdom." The law of gravitation was extended beyond the limits of the Solar system to the "star depths." So, while this great discovery of multiple suns was made, the question of parallax remained unanswered, and it was not till 50 years later that Henderson and Bessel at last succeeded in ascertaining the distances of two of the nearest stars from our system. The latter astronomer, by measuring the distance of a small star of the 16th magnitude, known as 61 Cygni from neigh-

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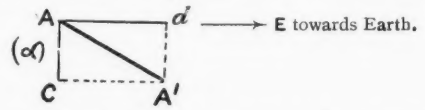
bouring stars during the course of the year, at last got some results.

Though, as we have said, the stars are "fixed," their positions changing so little that in the course of centuries no difference can be perceived by the unaided eye, yet by means of the telescope the careful measurements of modern science have shown small changes in place, in no case, however, amounting to more than 9″ (9 seconds of arc) per annum, and these changes, being peculiar to each star and differing for different stars, are known as "proper motions." The "proper motion" of 61 Cygni being considerable (about 5 seconds per annum), whilst many of the neighbouring stars showed little or none, it seemed reasonable to suppose that this star was nearer to us than the others, and would, consequently, be displaced with regard to them, by "parallax" arising from the earth's motion during the course of the year. This was, accordingly, found to be the case, but the displacement was so small (considerably less than one second of arc) that its detection and measurement are justly regarded as great triumphs of skill. So vast is the distance of 61 Cygni that light travelling at the rate of 186,000 miles per second takes 10 years to accomplish the mighty journey. The star, Alpha Centauri, whose distance was first determined by Henderson at the Cape, and later by Sir David Gill, is of the first magnitude, the third brightest of those in the sky (only being exceeded by Sirius and Canopus in this respect), and is somewhat nearer to us than is 61 Cygni. It is the nearest of all the stars to our system, as far as is yet known, being at a distance of about 26 billions of miles, a distance travelled over by light in about 4 years. Thus vast are the distances from us of even the nearest of these bodies! A few other stars are at distances from 3 to 10 times that of Alpha Centauri, but he vast majority must be yet further off, the remoter ones amongst those visible in a powerful telescope probably requiring a "light passage" of hundreds, and even thousands, of years. Sirius, the brightest star in our sky, is at about the same distance from us as 61 Cygni, and has been estimated to exceed our own sun at least 40 times in luminosity, and *possibly* in size, whilst Canopus, the brightest star in the constellation of the Ship "Argo" (now often sub-divided into smaller constellations), is so distant from our system that neither parallax nor proper motion have been as yet detected. Yet as its brightness is not far inferior to that of Sirius, it must be hundreds and, perhaps, thousands of times brighter than the sun, and is, in all probability, a star of giant dimensions. Rigel, the brightest star in Orion, is also immensely distant, and must be of great intrinsic luminosity. On the other hand, we have certain indications that there are also in the sky stars much smaller than our sun.

The Copernican system having placed the sun as the central body around which the earth and the other planets, comets, and meteors move, it was for long supposed that the centre of our system was at rest.

It was, however, the sublime discovery of Sir W. Herschel that the sun, too, is in motion, just as we have seen is the case with the stars, and he not only detected this, but gave a good approximation to the *direction* in which it is moving, though neither in his day nor in our own do we know anything *definite* as to the *speed* of the motion with which it travels, taking with it its family of planets, satellites, comets, and meteors. The "proper motions" of the stars are thus due partly to their own motion, and also partly to any motion which the sun may have. To use Herschel's illustration. Suppose we are walking in a forest filled with trees; those trees towards which we are moving will be seen to separate further apart, those from which we are receding will appear to close up and come closer together. In a paper which he contributed to the "Philosophical Transactions" of the Royal Society for 1783, Herschel gave a diagram showing the effect such a motion would produce on the positions of 14 of the principal stars, and concluded that *nearly all* of these agreed with the observed motions (22 of 28) if we suppose the direction in which the sun is moving (apex of the sun's way) to be near the star λ (Lambda) Herculis. Since at that time nothing was known as to the distance of any star from us, the *speed* of this motion could not, of course, be determined at all, but "in a general way" Herschel estimated it not to be less than that of the earth in its annual orbit round the sun, and we can say no more in this respect even now. Since Herschel's time investigations have been made by Argelander, Airy, Oscar Stumpe, and others, all agreeing fairly well on the position of the "apex," though Stumpe and Campbell place this nearer to the constellation Lyra, perhaps not very far from the bright star Vega, well known to all observers in our latitudes, since it is always visible (circumpolar) on any fine night, though it is at times close to the horizon. The application of the spectroscope has given us actual estimates of stellar velocities in the line of sight (approach or recess), but since we have no means of telling how much is due to the stars' own motions and how much to our own, and, after all, this is only part of the whole motion, we cannot often determine the true rate of movement. If we suppose a star moving in the direction A A′, inclined



to the line of sight A E, it will seem to have moved in the direction A *c*, "the proper motion," as determined by the telescope (in *angular measure*). Its distance from the earth will have diminished by A *d*, and this may be determined (in miles per second) by the spectroscope. Till we know the distance A E we cannot combine the angular value of A *c*, with the linear one A *d*, and this distance is known only in the case of a very few stars. We may, however, sometimes assign a *minor* limit less than which the speed cannot be. Thus, in the case of the well-known "runaway star" 1830 Groombridge, which, till recently, was that which had the greatest known proper motion (7 seconds per annum), its speed cannot be less than 200 miles per second, and may be much greater. Professor Newcomb has, accordingly, estimated that not all the attractions of the whole stellar system can stop it, and that it is, accordingly, rushing on a boundless course through infinite space (unless there are *dark bodies* exceeding the luminous stars in material which may check its course).

As for the nature of the path which the sun describes, whether it is rectilinear or curved, and if the latter, whether the curve is a closed or open one, nothing is known. Some 50 years since Mädler supposed that "our sun, with its whole system, and the other stars are moving in immense orbits round a centre at or near the star Alcyone in the Pleiades," but though there seems much reason to suppose that the Pleiades group may partake of such motion, yet there is nothing to warrant its extension to our own sun and other stars. Thus, Mädler's conclusions are now very generally disregarded. "The *solar* system," says Professor Young, "is an absolute monarchy with the sun supreme. The great *stellar* system appears to be a republic, without

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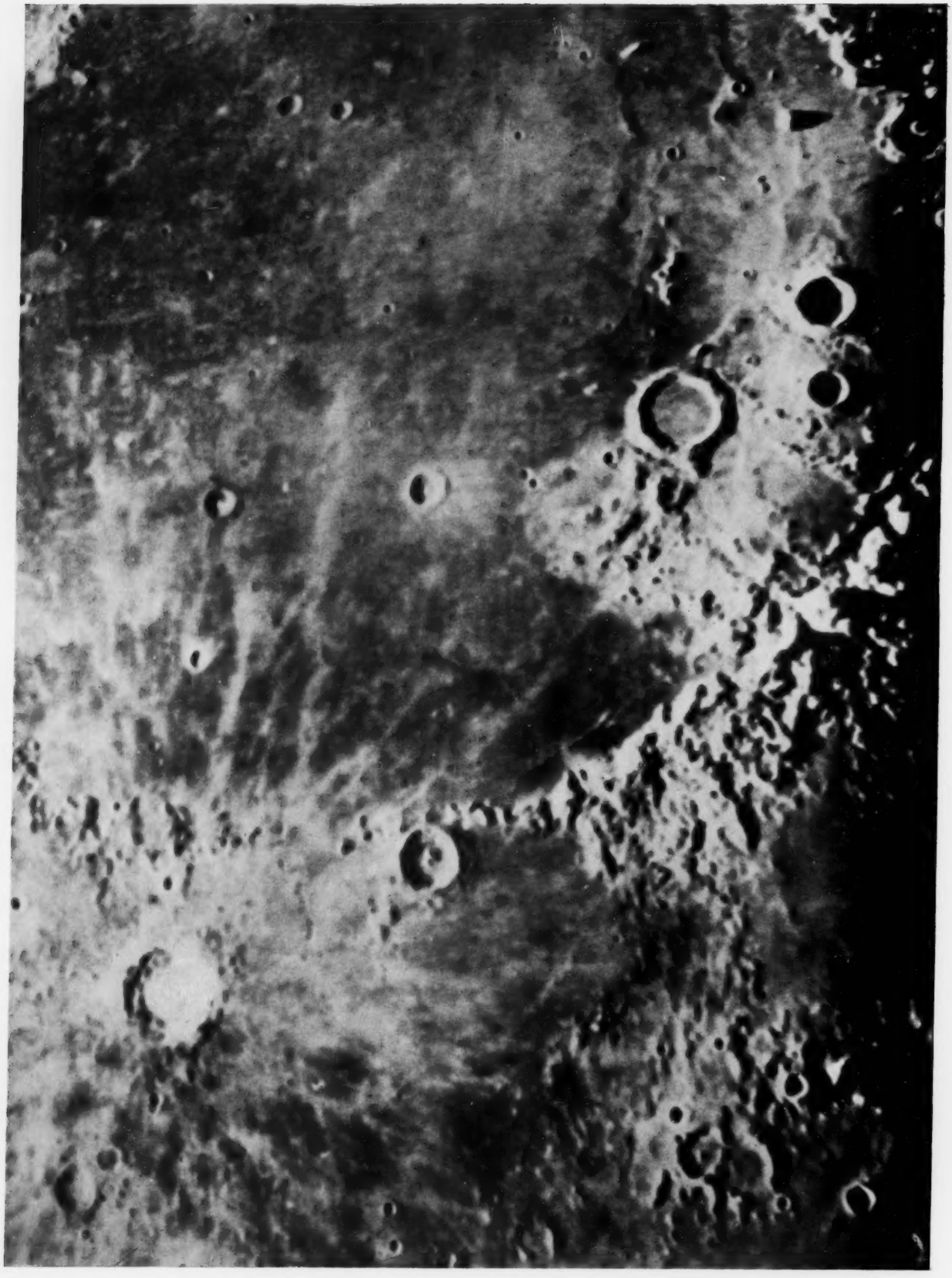

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The Moon.

any such central, unique, and dominant authority." Nevertheless, the phenomena of star-drift, double and multiple stars, etc., all show intimate connection between groups of stars, which are sometimes widely separated in space.

The late Mr. Proctor and others showed that five of the stars in the well-known "Plough" have proper motions of nearly the same amount and direction, and Huggins has determined by the spectroscope that these five are all receding from us at the same rate. Most of the Pleiades stars have similar proper motions, and seem to be of nearly the same chemical nature. Other cases of "star drift," as this community of proper motion is called, have been noticed by different astronomers.

Professor Kapteyn, Mr. Eddington, and others consider that the stars in the Milky Way may be roughly separated into two great "drifts." The stars in one group are moving relatively to the sun with a speed about three times that of the stars in the other group, and the members of each group are distributed in about equal numbers throughout the portions of the sky examined.

Thus, nothing in the Universe seems to be at rest. Our earth is in rapid motion around the sun, the latter is moving on an unknown path towards other regions of the Milky Way, and the stellar system of which the sun is one unit is itself also in motion. The famous hypothesis of Lambert of "systems beyond systems" may fitly conclude this sketch.

His first system consisted of a planet with its satellites, such as the earth and moon, Jupiter and his satellites, etc. These, in their turn, revolve round the sun, forming the Solar system. He then supposes a number of solar systems, each formed of a star and its planets, revolving and grouped into a greater system. A number of these groups form the galaxy (or Milky Way), which, with other more distant systems, may revolve round a yet greater one, and so on, without end. Modern research has shown that the so-called "atom" or unit of chemistry may be in many respects likened to a solar system, with a positive nucleus (like a sun), having negative electrons (like planets) revolving around it. "End there is none to the Universe of God. Lo, also there is no beginning."

A Chronological Comparison of Geological Periods.

MANY leaders of science, such as geologists, palæontologists, astronomers, and physicists, have variously calculated the time which has elapsed since life first manifested itself on our earth at from one hundred to two hundred millions of years. If, for argument sake, the shorter time be taken, and an attempt made to reduce this vast period of creation to an understandable unit such as twenty-four hours, as has been done by Dr. H. Schmidt, of Jena, it will be found that the five evolutionary periods, through which most are agreed life has extended, would make up one day as follows :—

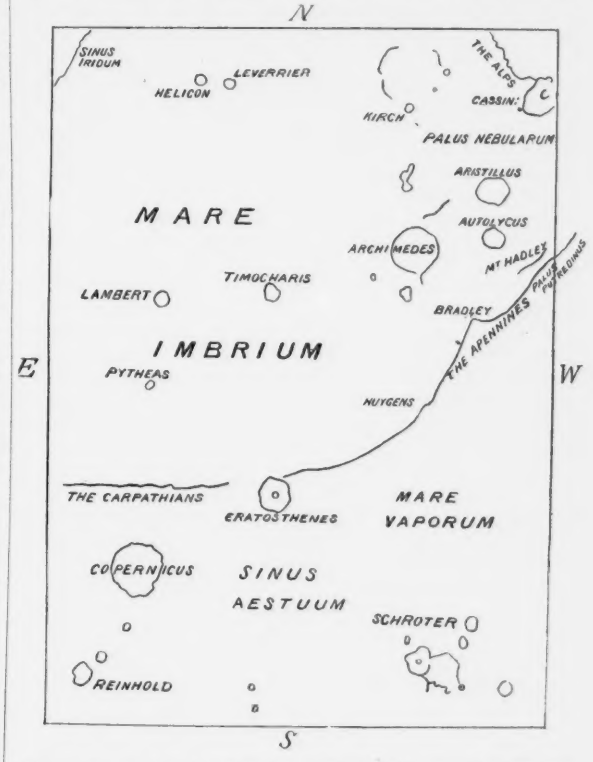
1. Archeozoic	period	(52 million years) =	12 hrs. 30 mins.
2. Paleozoic	,,	(34 million years) =	8 hrs. 7 mins.
3. Mesozoic	,,	(11 million years) =	2 hrs. 38 mins.
4. Cenozoic	,,	(3 million years) =	43 mins.
5. Anthropozoic	,,	(1-100,000 years) =	2 mins.

Analysing this latter period at the same rate, it will be found that the "historic" portion extends to only *five seconds*, while *two seconds* would suffice to cover the Christian area. Such a calculation seems incredible, and yet the evidence of its correctness appears on every hand.

Photograph of the Moon.

THE accompanying plate of the moon represents the central portion of the N.E. quadrant, containing the Mare Imbrium, Sinus Aestuum, Mare Vaporum, Palus Putredinus, and Palus Nebularum, the mountain range of Apennines and Carpathians, and the craters or ring-plains Reinhold, Copernicus, Schröter, Eratosthenes, Archimedes, Aristilles, Cassini, etc.

Mare Imbrium is the largest of the dark grey plains of the moon. It is bounded on the S. by the *Carpathians* and *Apennines*, the former of which are 125 miles in length and consist of a great mass of mountains placed side by side, separated by valleys and connected by small elevations; the height varies from 2,500 feet to 7,000 feet. The *Apennines* extend for 184 miles from



N. to S., and 166 miles from E. to W.; on the W. by the Caucasus and Alps, on the N. by the highlands of Plato and the Sinus Iridum, and on the E. by the Oceanus Procellarum. Its length is 751 miles, breadth 678 miles, and area about 340,000 square miles.

Sinus Aestuum, a plain having a length of 130 miles, breadth 170 miles, and area 14,000 square miles. Many low ridges traverse it.

Mare Vaporum, a plain containing numerous ridges having a general direction from N.E. to S.W. The highest peak rises 2,880 feet.

Copernicus is a very well-known lunar crater 56 miles in diameter; the summit, consisting of a nearly circular ridge, rises 11,000 feet above the bottom. At full moon it is surrounded by radiating streaks of a brilliant white colour. A mass of ridges lean upon the outer wall, and the central mountain has six heads, two of which are conspicuous. Copernicus is surrounded by a great many mountains and ridges separated by deep valleys.

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Eratosthenes is a strongly terraced ring-plain more than 37 miles broad, with rugged walls which are highest on the east, where one peak rises 7,449 feet above the outer surface and 15,808 feet above the interior, whilst on the west they are only 9,880 feet above the interior. In the centre of the plain are three peaks placed in a triangle. It is supposed to have been the outbreaking crater of the great Apennine range.

Archimedes, a walled plain 60 miles in diameter and depressed only about 650 feet. The wall averages 4,200 feet above the interior and has several peaks, the highest being about 7,400 feet.

Autolycus, a circular ring-plain 23 miles in diameter and of considerable depth, rising on the E. side 9,017 feet and on the W. 8,358 feet above the interior. The floor is level, whilst the walls are broad and regular, containing many peaks, and there is a low hill in the centre.

Aristillus, a very fine ring-plain 34 miles broad and 11,000 feet deep on the E. side. There is a mountain in the centre.

Cassini is a ring-plain 36 miles in breadth surrounded by a narrow wall rising 4,368 feet above the interior on the N.W., and 4,131 feet above the outer surface, becoming lower towards the S. and only 1,500 feet on the E. The most conspicuous object it contains is a very small plain 9 miles in diameter, having a central peak.

Kirch, a small ring-plain 2,300 feet deep.

Leverrier and *Helicon*, twin craters, each 13 miles broad and of vast depth.

Reinhold, a ring-plain nearly 31 miles across with broad, steep walls.

Timocharis, an isolated ring-plain 22 miles broad with a terraced wall.

Lambert, 17 miles in diameter, with a central peak over 3,006 feet above the plain.

Pytheas, nearly 12 miles across with a central peak and wall rising about 5,000 feet above the interior.

ENCKE'S COMET AND METEORIC STREAMS.—It is well known that Encke's theory, that the acceleration of the mean motion of the comet which goes by his name was due to the effect of a resisting medium, has had to be abandoned on account of the change in the amount subsequently manifested. Herr Hackenberg, of Vienna, has made some provisional attempts to show the possibility that it might be due to the action of meteoric streams, if they consisted of bodies of considerable size and number. Should such follow a comet, they would accelerate its motion; should they precede the comet, they would retard this. As we know that, in the case of Encke's comet, the effect was accelerative, this might help us in discussing the question. Certain assumptions must be made with regard to the density and shape of the meteoric stream and its distance from the comet, the last being compared with that of Biela's comet from its stream, which may have had something to do with the division of the former into two parts. Herr Hackenberg was strengthened in his views by noticing a remark of Prof. Backlund on the possible perturbing effects of a meteoric swarm, but want of time compelled him to postpone the publication of his work. Meantime appeared (in 1906) the excellent investigation of Herr Charlier on the acceleration in the mean motion of comets, which gave a satisfactory confirmation to his theory. But he is awaiting an opportunity of applying it to the motion of Encke's comet.

The Moon and Sanskrit Sacred Literature.

By IRENE E. TOYE WARNER.

MANY are the myths invented to explain the waxing and waning of the moon among ancient peoples, the most elaborate being that of the Sanskrit-speaking inhabitants of ancient India. Our satellite plays an important part in Sanskrit literature. Vedic poetry is chiefly about the sun, moon, sky, wind, storm, and fire. The moon is often called one of the eight vasus or bright gods under the name of Soma, and her phases were well known. "Let us bring wood, let us prepare the libations, thinking of thee [Agni = fire, also sun] at every phase of the moon," says one hymn in the Rig-veda; and a very old riddle asked by the priests was: "Who walks alone, and who is born again? What is the medicine for cold? What is the great vessel?" the answer being: "The sun walks alone, the moon is born again, Agni, fire, is the medicine for cold, the earth is the great vessel." Another name for the moon in Sanskrit is Mâs, the "measurer," which, says Max Müller, is closely connected with the Latin mensis, English moon. In the later Sanskrit Brâhmanas, Pragâpati, the lord of living creatures, was called the father of Aditya the sun, Kandramas the moon, and Ushas the dawn. A corruption of this name Kandramas probably exists in India among the Santhals as Chando, which means "bright." In the Vedas a lunar year was used consisting of 12 months, with the occasional addition of a thirteenth, the seasons sometimes being called the "brothers of Soma," the moon.

It is as the abode of the souls of the departed that the moon chiefly claims attention in the Sanskrit writings, and many descriptions are given as to when and how the soul reaches this distant resting-place on its upward or downward journey. It was thus that the moon waxed and waned, when the departed entered or left their celestial home. To a people who believe in the transmigration of souls, the idea of a brief tarrying in the midst of the almost endless round of existences must have been very welcome. In one Upanishad it is stated: "All who depart from this world go to the moon. In the waxing half the moon waxes bigger by their vital spirits, but in the waning half the moon causes them to be born. Verily, the moon is the door of the heavenly world." They supposed that on reaching her the soul had to answer several questions on which, if it could do so rightly, the moon would at once set it free to continue its journey to the world of Brâhman, the Supreme Being; but if, on the contrary, it could not answer, then the soul was considered unfit to progress further and was showered down to the earth in the form of rain, in the course of time to be born again, as a man or an animal, according to its deeds.

It was a common belief in ancient India, says Max Müller, that the moon was the source of life and immortality, and that it consisted of something like the Greek nectar which gave immortality to the gods. Thus the waning of the moon came to be regarded as caused by the gods consuming this Soma (or moon-juice), and its waxing by the entrance of the spirits of the departed; then, naturally, the souls were said to be the food of the gods in a spiritual sense, being one when consumed with the Supreme Being. The moon, then, became the visible pledge and giver of immortality, and in many Vedic hymns of great beauty

she is implored for this gift: "Where there is imperishable light, in the world where the sun is placed, in that immortal, eternal world place me, O Soma! . . . where the ever-flowing waters are, there make me immortal, O Soma! Where one moves as one listeth . . . where every place is full of light . . . where the wishes of the heart are fulfilled, there make me immortal, O Soma!" (IX., 113, 7). Truly one could not wish for a more beautiful description of the home of the blessed.

In the Rig-veda it is said: "The moon prolongs a long life." She also was the giver of rain—a most important thing in hot countries. The idea that the spirit would dwell in the moon with the Fathers who had gone before was very widely spread in ancient India, and was regarded as a reward for good deeds done on earth. Therefore, when this reward was exhausted it was necessary for it to be born again on earth in a high or low estate, according to the deeds done in the body, to begin another round of existences, as I have said, until considered perfect enough to become one with the Supreme Being—which is the aim of all Hindu philosophy, ancient and modern.

The departed Fathers are often invoked in the prayers of the Rig-veda: "May the Soma-loving Fathers (who have reached the moon) . . . who have come to life again, protect us in these invocations! May this salutation be for those who have departed before or after, whether they now dwell in the sky above the earth or among the blessed people; . . . Come hither with your most blessed protection, and give us health and wealth without fail!"

The unknown author of the grandest Sanskrit poem ever written, and, indeed, one of the most beautiful and truly religious compositions now in existence—"The Song Celestial," translated by Sir Edwin Arnold when giving a description of the Supreme Being says:—

> "Silver of moon and gold
> Of sun are glories rolled
> From Thy great eyes; Thy visage beaming tender
> Throughout the stars and skies,
> Doth to warm life surprise
> Thy Universe. The worlds are filled with wonder
> Of Thy perfections."

In another place where the Supreme Being states His attributes He says: "I am the silver of the moon, the gold of the sun . . . but all are merged in me—not I in them!" And again:—

> "By day I gleam, the golden sun of burning,
> cloudless noon;
> By night, amid the asterisms I glide, the dappled
> moon!"

The ancient races of India had evidently noted the dark patches and crater-like objects visible to the naked eye on the surface of our satellite. It would be difficult to find a better description of God's omnipotence and omnipresence than is contained in this beautiful old poem.

The poet speaks of the eternal world of the future and says: "Another sun gleams there! Another moon! Another light, which they who once behold return no more." As a last quotation from the Mahâbhârata I may give the following:—

> "Numberless now I see
> The aspects are of Thee;
> Moon and starlight are Thine! Prajâpati
> Art Thou, and 'tis to Thee
> They knelt in worshipping the old world's far light,
> The first of mortal men."

Evolution by Atrophy.

By W. P. PYCRAFT.

THE study of the transformations of animals, though fascinating, presents many difficulties, and this is especially true in cases where this transformation is accompanied by the atrophy of organs generally regarded as essential to the well-being of the individual. The atrophy of the wing in birds may be taken as an excellent example of this kind of transformation, presenting as it does a large series of gradations ending in the absolute disappearance of the whole limb.

Let us pass the more salient features of this evidence of degeneration in review before proceeding to discuss the ætiological aspect thereof. To begin with birds which depend for existence on their ability to fly far and at great speed have long pointed wings—that is to say, wings in which the outermost primaries are the longest in the series—as, for instance, in Swifts and Swallows, Falcons and Albatrosses. But the length of the feathers is not correlated with a corresponding similarity in the length of the segments of the bony supporting skeleton. Thus the Swifts have the shortest humerus of all flying birds, the Albatross the longest, yet the contour of the expanded wing in the living bird is strikingly similar. In birds which haunt woods and thick undergrowth the wing assumes a rounded form, owing to a shortening of the outer primaries, and one can find many striking contrasts illustrating this point. Thus, the Short-eared Owl (*Asio brachyotus*) has a wing of the pointed type; it is a migratory species, and hunts in the open; the Tawny Owl (*Syrnium aluco*), a wood-haunting, non-migratory species, has a short rounded wing. One might cite dozens of similar cases. Wherever this rounded type of wing is presented, there it will be found the bird has no occasion for energetic flight, and may even be flightless.

Among flightless birds one meets with a series of insensible gradations from wings apparently fully developed and capable of flight to mere vestiges, and finally even these disappear as in the case of the Moa, when not even a trace of the socket of the wing appears on the shoulder girdle! No useful purpose would be served here in making an exhaustive list of species illustrating this down-grade process, suffice it to say that it can be swiftly followed by comparing, say, the wings of the flightless Rails, or of the Kakapo Parrot, with those of the Rhea, Ostrich, Emu, Apteryx, Cassowary, Æpyornis, Hesperornis, and Moa.

The Rails in question present a perfectly normal wing, but one in which the muscles are too feeble to raise the body from the earth. In Rhea degeneration has proceeded to a far greater length, especially in so far as the skeleton and musculation is developed. But, it is to be noticed, it can still be flexed, as in birds with functional wings. In the matter of its feathering it presents certain peculiarities which cannot be easily interpreted. Thus, the primaries are more numerous than in flying birds, but the major coverts thereof have apparently increased in length, being as long as the quills to which they are attached; as coverts they are enormously long. But, having regard to the primitive character of this bird, this fact may be normal, while the primaries may have become shortened. Finally, the feathers throughout the whole body are degenerate in character. That this wing is a degenerate organ of flight there can be no sort of question, and hence we shall not labour this point. The wing of the Ostrich is more degenerate, in that it cannot be flexed, but in the matter of the quills it seems to be less degenerate than in any

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other of the Ostrich-tribe, or Palæognathæ. In the skeleton it may be remarked, arm, fore-arm, and hand are all complete; in one particular, indeed, more so than in any other birds, since traces are occasionally found of an ungual phalanx to Digit III. In the Ostrich the manus is longer than the fore-arm, in Rhea the reverse is the case. In the Emu the process of degeneration has proceeded much further. As in the Ostrich, anchylosis at the wrist-joint and between the phalanges has taken place; the hand, indeed, has become extremely reduced, the pollex has disappeared, and the metacarpals and phalangeals have fused into one indistinguishable mass of bone. The whole wing, indeed, is scarcely longer than the skull.

Of the feathers little can be said, save that it is no longer possible to distinguish between flight-feathers and coverts. The wing of the Cassowary, curiously enough, though relatively smaller than that of the Emu, is less degenerate, inasmuch as three metacarpals are traceable, that of the pollex being the most reduced. Of the phalanges all that remains is a vestige of Digit II. Of the carpal bones only the radiale is traceable. The Cassowary, like the Emu, was evidently, in the hey-day of its development, a short-winged bird, or, at any rate, had a short humerus, wherein these birds differ from Struthio, Rhea, and Apteryx, which were all long winged.

In Apteryx the degeneration of the wing has reached a stage somewhat intermediate between that of the Emu and Cassowary, but the hand is more reduced than any other of the flightless birds.

Finally we come to the wing of the ancient Diver, *Hesperornis*, of the Cretaceous, and the *Æpyornis* of a quite recent geological period. Herein only the humerus remained, and this was represented by a mere rod of bone showing but traces of the condyles for the articulation of the fore-arm. In the Moas, as we have remarked, even this last remnant of the wing had vanished, and the memory thereof had been erased, as it were, even from the shoulder girdle since the socket for the wing is conspicuous only by its absence.

All these wings, it is significant to note, present a less degraded condition during earlier stages in their ontogenetic development; even the most degenerate. Thus, in the nestling Cassowary a radiale, ulnare, and a distal carpal mass are plainly distinguishable; more cannot be seen in the development of the functional wing at the same stage.

So far this survey has been confined, briefly, to a review of the skeleton of the wing, but there are certain facts with regard to the exoskeleton which demand more attention than they have hitherto received.

In all the wings herein described, save only in the Cassowary, and in Apteryx, this exoskeleton presents a practically unbroken course of degeneracy. But in the birds just referred to this process of degradation has been transformed into one of specialisation, at any rate, in so far as the remnants that remain of the quill or flight feathers is concerned. These, in the Cassowary, are five in number, three representing secondaries, or the quills of the fore-arm, and two those of the primaries or quills of the hand. These remnants take the form of long, blunt-pointed, cylindrical spines, of considerable thickness, and were supposed to represent a much-thickened feather shaft, from which the vane, or feather web, had disappeared. As a matter of fact, they answer merely to the calamus, the hollow, or "quill" portion of the feather shaft; and this it was my good fortune to be able to prove some time ago, after examining the wings of a number of nestling Cassowaries. Herein I found that the remiges, as in those of normal type, consisted of a well-defined calamus or quill, and a rhachis, or shaft, bearing a degenerate vane. This degenerate condition of the shaft is further shown by the fact that it lacks the inner supporting layers of pith cells, so that it is made up simply of a long, scroll-

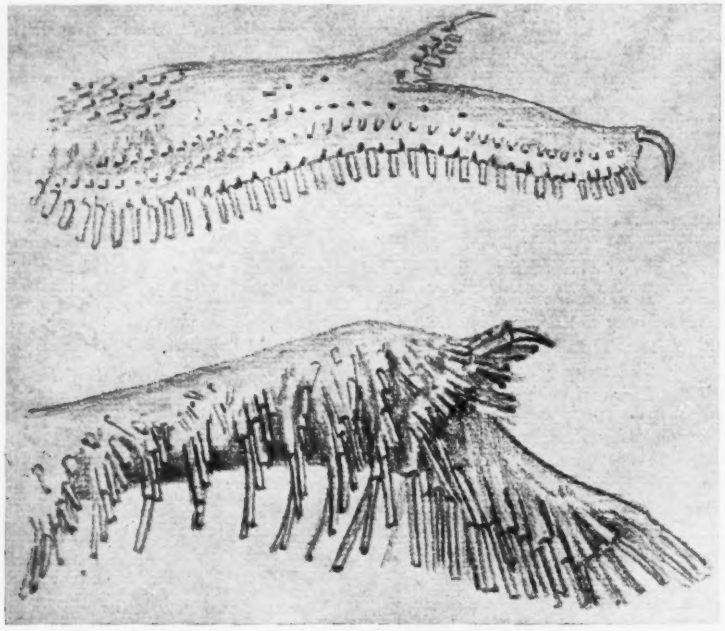

Fig. 1.—Stages in the degeneration of the wing. The lower figure shows part of the fore-arm and hand of Rhea, wherein the hand can be flexed at the wrist-joint. The upper figure shows the wing of the Ostrich (*Struthio*), wherein the hand has lost the power of flexion.

like lamina of horn. In normal feathers this shaft is formed by a prolongation of the dorsal segment of the calamus so that it forms but a semi-circle, instead of a tube; as growth proceeds the consequent free-edges of this hemi-tube turn inwards so as to enclose the pith, but in these degenerate feathers the inturned edges merely enclose a cavity. A little later in development, however, this distal, vane-bearing portion of the feathers is shed, while the remaining calamus goes on increasing in length, and at the same time completely changes its normal character by becoming solid!

Fig. 2.—The wing of the Cassowary (upper figure), showing the remarkably modified remiges (1-6) and the greatly reduced hand, only one carpal and a vestigial manus being left. The lower figure shows the wing of Apteryx wherein the manus has become almost suppressed; Digit II., however, still has a claw.

This curious phase of development explains why it is that the ends of these spines, in the adult bird, always present a ragged appearance.

It could hardly be supposed that any intermediate stage in the development of so curious a history would be found in any other bird, yet such is the case, and this stage is presented by the Apteryx. Herein the basal portion of the vestigial remiges is hollow, as in fully developed feathers, but it further presents a peculiarly inflated appearance—a forecast of what is to be in the Cassowary—the distal region of the feather agrees precisely with that seen for a time in the nestling Cassowary, but in Apteryx this is retained throughout life, and, further, has a less degenerate vane. In other words, the remiges of the nestling Cassowary agree in all essentials with these feathers in the adult Apteryx. In Apteryx, however, they present, if one may so, a perfectly natural stage in degeneration, but in the Cassowary these feathers must certainly be regarded as presenting a specialised condition. Yet to what purpose? They can scarcely be regarded as ornamental, neither can they serve any conceivable purpose as weapons of offence or defence, for they are in themselves incapable of inflicting wounds, and the wing which bears them is too feebly served by its muscles to wield such weapons. Unique of their kind, it is difficult to regard these structures as simply degenerate, for the pathway to disintegration is not one that could be expected to furnish material for renewed activities and the increase of tissue. At present, then, the matter must rest in this domain of uncertainty.

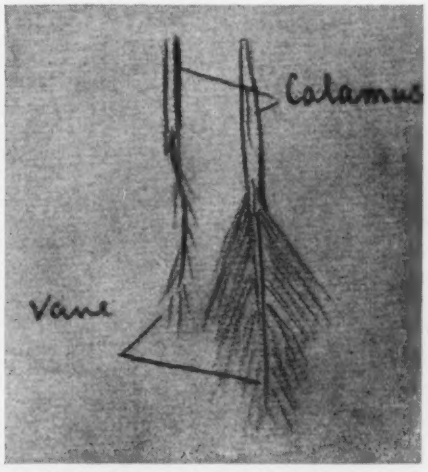

Fig. 3.—An early stage in the development of the quill-spines of the Cassowary, showing the shaft and vane (vestigial) still attached to the calamus (left-hand figure). The right-hand figure shows a quill feather of an Apteryx, with its swollen calamus, and degenerate rhachis and vane.

Mention was made of the fact that the Great Auk, among flightless birds which had preserved the semblance of a wing, was peculiar in that it presented a pointed, and not rounded, wing, therein resembling, by the way, its relatives the Razor-bills and Guillemots. This exception to the rule, however, is easily explained, for the wing, though too small to support the body in the air, was used, as among its surviving relatives, as a paddle when under water, so that, though degenerate as to flight, it was still a functional organ. This wing, in fact, affords a good illustration of the way in which, by a change of function, new organs come into being. The paddle of the Penguin, for example, we may surmise, had its origin in just such a wing, for it is certain that this paddle at some earlier period served the purposes of flight. (*To be continued.*)

THE portrait of Charles Darwin, which was published in the July number of "KNOWLEDGE," and which was described as the photograph of himself that Darwin liked best, was taken in 1868 by Mrs. Cameron. The copyright of the photograph belongs to Mr. John Murray, and the portrait appears as a frontispiece of some of the works of Darwin which are published by him. We were ignorant of this when we reproduced the photograph, and we hasten to acknowledge our indebtedness to Mr. Murray, while regretting that we did not do so at the time.

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The Takin.

By R. LYDEKKER.

TILL a few weeks ago most people, I think I may safely assume, had never heard of such an animal as a takin, but now that a fine young bull of the Bhutan representative of these curious ruminants has arrived at the Zoological Gardens the name has become familiar, and everyone who has paid a visit to the Regent's Park for the purpose of seeing it is anxious to know more about the stranger, which is the first living specimen of its kind ever seen in Europe. As to the name, which is of Chinese origin, people will pronounce this as though it were *take-in*, whereas the proper pronunciation is, I believe, more like *tarkin*, with a nasal intonation of the

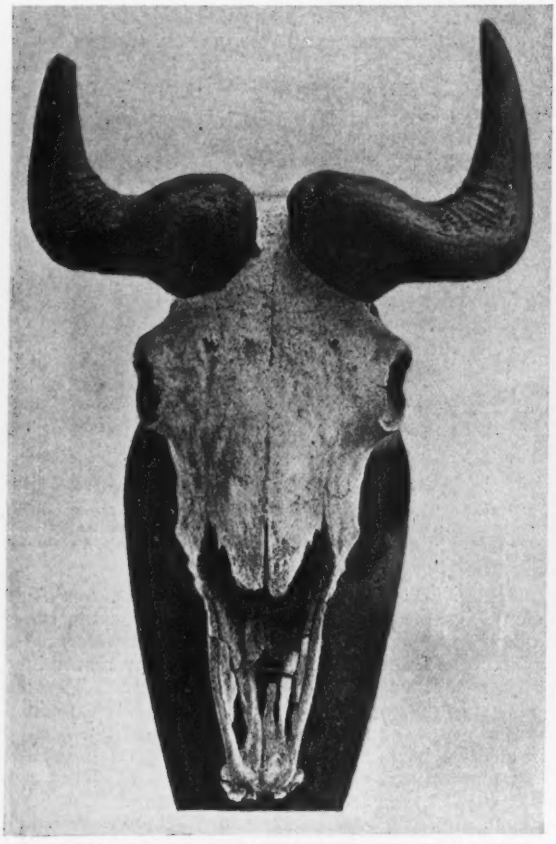

Fig. 1.—Skull and Horns of an Adult Bull of the Bhutan Takin (From *Proc. Zool. Soc.*).

final letter. In fact, as in the case of many Malay and Chinese words, the name, according to old-fashioned orthograhpy, would be spelt with a final *g*—*taking*, just as we used to have Peking instead of Pekin, thameng in place of thamin (the Burmese deer), and banting in lieu of bantin (the Malay wild ox). Scientifically takin are known as *Budorcas*, a name signifying ox-gazelle, or ox-antelope, in allusion to the bovine form of the horns.

Takin, for there are two species, were first made known to science in the year 1850 by the late Mr. Brian Hodgson, some time British Resident at Khatmandu, the capital of Nepal, where specimens were brought down from the country of the Mishmis, a hilly district visible from Northern Assam, but impenetrable to Europeans on account of the hostile disposition and fierce character of the natives. For many years after this specimens of these animals were exceedingly rare in collections, although an occasional pair of horns or a skin was brought into British territory by traders. Sufficient was, however, known to enable naturalists to form a fair idea of the general structural characters of the animal, although complete specimens of the skull were lacking and practically nothing was known with regard to its habits. There was, moreover, a difference of opinion with regard to the shape of the horns of the female, some naturalists believing that they were like those of the males, but shorter, while others believed them to be straight.

This typical Mishmi takin—the *Budorcas taxicolor* of its describer, Hodgson—is a clumsily-built ruminant of the size of a small Kerry cow, with stout limbs, large lateral hoofs, a short, goat-like tail, and a large, heavy, Roman-nosed head, surmounted in the adults of both sexes with a pair of thick black horns which are sharply ridged in front and bend at first almost directly outwards, but afterwards are suddenly turned upwards; those of the cows being similar to, but smaller than, those of the bulls.

Fig. 2.—A Dead Sze-chuen Takin, from a photograph by Mr. J. W. Brooke.

In winter the coarse hair forms a long and shaggy coat, but in summer this is replaced by a shorter and thinner covering, of which the general colour is deep reddish-brown, with a dun-coloured saddle on the back, and a dark stripe down the middle line of the latter and the neck; the feet being dark and the face black. A bull takin will stand about 3½ feet at the shoulder, with a length of about 6½ feet to the root of the three-inch tail.

As I have said, takin were long known only from the Mishmi country, but during the sixties a representative of the group, now known as *Budorcas tibetanus*, was discovered by the well-known French missionary, Père David, in Sze-chuen, North-Western China. For years this Sze-chuen takin, which extends northwards into the adjacent province of Kansu, was known only by the skins sent to Paris by Père David, but during the nineties a specimen from Kansu was acquired by Mr. Walter Rothschild, and is now shown in the museum at Tring, while later still several examples were obtained by the British Museum, of which a male and a female are exhibited in the public galleries of the Natural History Branch at South Kensington. Im-

mature males of this Chinese takin are distinguished by the golden colour of the long hair of the fore-quarters, the more slender horns, and the longer and narrower skull; while in females of the same age the general colour of the body is light grey or even whitish. Several specimens of this takin were obtained from native hunters by the late Mr. J. W. Brooke, who was foully murdered by the natives of Sze-chuen in December, 1908, and a female was actually shot by his friend and companion, Mr. Mears. Skins and horns of the Chinese takin have likewise been recently brought to this country by Captain Malcolm McNeill, while others

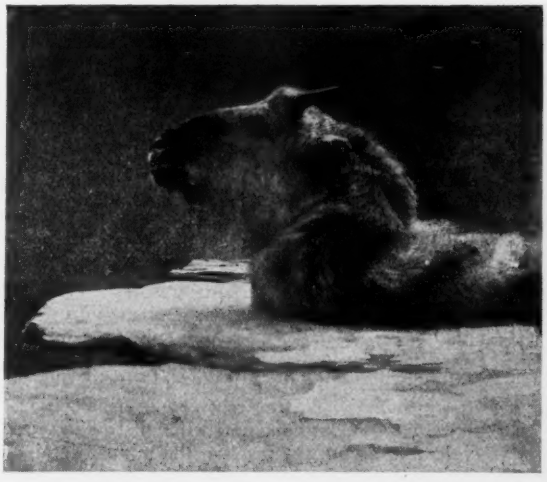

Fig. 3.—Side View of the Head of a Young Sze-chuen Takin, from a photograph by Mr. Brooke.

have been sent by the American consul in Sze-chuen to the United States.

This, however, by no means completes what we know about takin, for during the last few years Mr. Claude White, late British Commissioner in Sikhim, discovered the existence of a representative of these animals in the small hill-state of Bhutan, lying to the north-east of Darjiling, and separated from the Mishmi country by the deep gorge of the Bramaputra. Of this Bhutan takin, thanks to Mr. White and the Maharaja of Sikhim, quite a number of skins and skulls have reached this country, and these have enabled me to decide that they indicate a rather small-sized and small-horned variety or race of the Mishmi species, for which I have suggested the appropriate name of *Budorcas taxicolor whitei*. Of this race a young individual was brought into Mr. White's camp a few years ago, but it failed to survive the journey down country. A second attempt to bring a live specimen to this country fortunately proved successful, and it is to the influence of Mr. White and the young Maharaja of Sikkim that the public are indebted for the opportunity of seeing the fine young bull of the Bhutan takin now inhabiting an enclosure near the south end of the tunnel in the Zoological Gardens.

In this young takin the horns are comparatively straight, as in Figs. 3 and 4, and it was at one time suggested that this type of horn was characteristic of the females, although this is now known to be wrong. As in other ruminants, the horns grow from the bases, and the straight horns of the young eventually form the tips of those of the adult, the bend being developed during growth. If the young animal in the "Zoo," grows to maturity, as there is every probability, so far as can be seen at present, that it will, an excellent opportunity will be afforded of watching and recording the development of the horns.

When the horns are in the condition of the Zoo. specimen, a takin looks much more like a serow, or goat-antelope (*Nemorhædus*), of which the various species range from the Himalaya and the mountains of Sumatra and the Malay countries to Sze-chuen. And there can be little doubt that these serows are the nearest living relatives of takin. To say that takin and serows are either goats or antelopes is, however, incorrect, as they form a group in some degree intermediate between the two. Indeed, it is difficult to say exactly what constitutes a goat or an antelope, in the wider sense of these terms, as each group is almost indefinable.

Very interesting is the fact that in the later Tertiary rocks of the Himalaya are found the remains of an extinct takin, which has been named *Bucatra*, although, unfortunately, we do not know the shape of its horns. It agrees with the modern takins in the enormous size of the nasal opening of the skull, a feature common to several ruminants living at high altitudes, or on open sandy plains, and probably designed to afford additional facilities in connection with respiration.

Takin have, it has been suggested, another relative in the shape of the remarkable musk-ox of Greenland and Arctic America, which has nothing to do with either oxen or sheep. The horns of musk-oxen present

Fig. 4.—Front View of the Head of the Young Takin shown in Fig. 3.

a distant resemblance to those of takin, although with characteristics distinctly their own, and the two animals agree in the shortness of their tails (that of the musk-ox being quite rudimentary) and the large size of their lateral hoofs, as well as in their heavy and clumsy build and relatively large heads.

Musk-oxen, it may be added, although now restricted to the Arctic and sub-Arctic regions of the western hemisphere, were formerly spread over Northern Asia and Europe, inclusive of the British Isles, so that, from the point of view of geographical distribution, there is no reason why they should not have originated from the same stock as takin.

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As regards the habits of takin, all the information acquired with regard to the Mishmi species appears to be that it lives at high elevations and associates in large herds. This somewhat meagre information has been largely augmented by a letter written to me by Mr. Brooke from Sze-chuen a few weeks before his death.

From this it appears that throughout (or, at all events, for a considerable portion of) the year these ruminants live at an elevation of about 10,000 feet above sea-level in precipitous mountains clothed with a dense jungle of rhododendron and bamboo, and that they display almost incredible agility in ascending and descending slopes which look impracticable for such large animals. Consequently they are extremely difficult for European sportsmen to track and follow, more especially as during the summer months there is an almost constant downpour of torrential rain. From

Fig. 5.—Skulls and Horns of Male and Female Takin in the Newcastle Museum.

March to May the females descend, however, to the valleys to bring forth their young, which are suckled for only about a fortnight, and are able to shift for themselves at a very early period. So far as I can ascertain, only a single calf is usually produced at a birth. The best time to shoot the old bulls, which for a considerable portion of the year herd by themselves apart from their younger brethren and the cows, is in winter, when during heavy snowstorms they are driven to the valleys. Their sojourn in the lower grounds is, however, but brief, as the snow is rapidly thawed by warm southerly winds from the plains, and so soon as the thickness of the snowy mantle is diminished the takin once more betake themselves to their favourite Alpine resorts, so that if the sportsman is not on the ground at the right time he loses his chance. The females and young males associate in herds of from five to about fifty head.

Some Hints on Micro-Photography

By WHEATLEY BOVILL.

THE microscope is a highly scientific instrument, and the use of it may, under some circumstances, become so scientific as to require the knowledge of a professional microscopist, and the foregoing applies equally to the camera and microscope, considered as one instrument, with which micro-photographs are taken. But at the same time there is plenty of scope in both these branches of study for the amateur and beginner if they will but content themselves with the simple objects that can be examined or photographed with lower power object lenses.

As a matter of fact, the use of a microscope requires little, if any, more technical knowledge, in most cases, than does the use of a photographic camera, and it is intended in this article to deal with nothing that is not within the reach of the beginner not only in photography and microscopy, but in optics.

Many, if not most, amateurs have at some time made enlargements from their own photographs, and in so doing they have already encroached upon the realms of photo-micrography, but there is one difference to be noted between the results that can be obtained by enlargement with a photographic lens and a microscope lens. The difference is that you may enlarge a minute object to any number of diameters (that is, you may make the diameter of the enlarged picture any number of times greater than the diameter of the original object) with a photographic lens, but you will fail to show up, or, in technical language, to resolve, the minute detail of the object; whereas an enlargement with a microscope lens would show you all detail, although the actual picture might be no bigger, or even it might be smaller, than that taken with the photographic lens.

It is here that the beauty of a microscope comes in, for its power of resolving the details of an object, or section, does not lie solely in the size of magnification, but in the power of the object-glass; and if you have ever tried enlarging small objects with an ordinary lens you will at once notice the superior results obtained by using a microscope. Now, as to the class of microscope that a beginner will require—almost any apparatus will do (the lens not being here referred to), but, as a rule, it is better to use an old one of a good make, if not too old, than a new and cheap instrument.

An old and well-made instrument will generally be found to give greater ease in locating and placing the object and greater delicacy in adjusting the focus, but it will be well to make sure that the screw which receives the object-glass will take the modern standard screw, otherwise you will not be able to use modern lenses except with an adapter.

With regard to lenses, it is more difficult to give advice. Many old and many inexpensive modern lenses of low power are quite reliable, and since it is with low-power lenses that the beginner should work, the question must be left to his decision. Here, however, it may be noted that both the lens and instrument with which the accompanying photographs were taken bear the name of Smith, Beck, and Beck, which at once puts their age at about 50 years. At the same time, the instrument was an expensive one when new, and all the movements of the stage and the adjustments are still accurate and trustworthy.

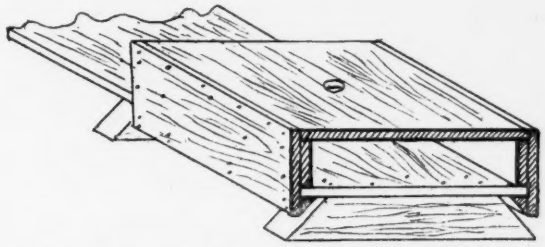
In buying object lenses and eye-pieces it should be remembered that all of these are not suitable for photographic work; in some lenses the visual and actinic

foci are not the same, and some eye-pieces do not project the image sufficiently for photographic purposes. The explanations of these qualities lie entirely in optics, and will not be dealt with, but it is sufficient to remark that any reliable optician or dealer will advise on this matter.

Presuming, then, that the beginner has a microscope and camera, the main question is to set these up on a stand so that they can be used as if they were one instrument. In the writer's opinion the simplest way is to use the microscope in a horizontal position, on a stand so contrived that the centre of the front board of the camera is on a level with the tube of the microscope, but so that the camera can be easily withdrawn or applied to the microscope without disturbing the focus of the latter.

To effect this, a stool having a hole in its centre for the camera screw and sliding on a board which will hold the microscope fully extended and the lamp, is very simple to make. A rough drawing is given in which all the parts of the stool, shown in the end elevation, are shaded in order to distinguish them from the board on which it slides. This stool should not only bring the centre of the camera in line with the microscope tube, but the camera when screwed to it should have its ground glass parallel in all ways with the glass slide on which the specimen is placed. Further than this, the microscope should be secured in some way to the board, as also should the lamp, and the flame of the latter should be in line with the object-glass and the eye-piece—thus all three parts, the lamp, microscope, and camera should be in line and parallel, and the whole apparatus must be considered as one instrument.

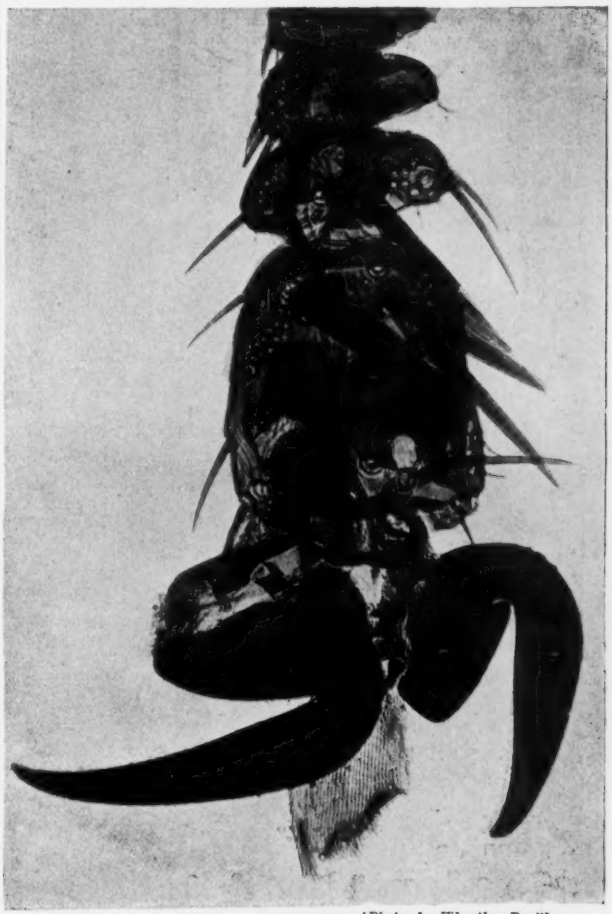
Such a stand as this could be easily made at home; it requires no great skill to put it together, and beyond having the sides of the board, on which the stool slides, quite parallel and the guides of the stool a fair fit, no great accuracy is wanted, but it will be well to note that the grain of the wood in the top board of the stool should run in the opposite direction to that shown in the sketch.



Stool for Camera; showing how it attaches to the board which holds the microscope and lamp.

To the front of the camera, in the opening where the lens works, you will have to fasten a cloth tube (light-tight) about 4 or 5 inches long, which must be bigger than the tube of the microscope, and must project outwards from the camera. In fitting the camera—already screwed to the stool—to the microscope, you slip the cloth tube over the eye-piece and secure it, either by tying or by a rubber band sewn into the hem at the end of the tube; in this way you make your camera and microscope into one light-tight compartment.

As to a light, an oil lamp will do, and suitable ones can be bought from any optician; but acetylene, incandescent gas, or electric light are better, and either of these can be easily adapted to your work, and should not be an expensive item. The first light used by the writer consisted of an acetylene bicycle lamp supplied with gas from a rough generator made of old tin cans. In taking photo-micrographs it is convenient to arrange, and get a focus on, your subject while the microscope is at a convenient angle. When this is done the microscope can be brought to the horizontal and the cloth tube slipped over the eye-piece. You will now find that your subject is practically in focus and the smallest touch of the fine adjustment of the microscope will complete the focussing, but it is as well to use a focussing glass to get very critical definition, and your ground



[Photo. by Wheatley Bovill.

Microphotograph of Foot of Forest-fly.

glass must not be too coarse. Here, let it be noted, that the amount to which your camera is extended will not materially alter the focus, and you will find that while each inch of extension makes a noticeable enlargement of the picture, the movement of the fine adjustment required will be very small.

By using the eye-piece in photography you gain the great advantage of a large picture with a short camera, for without the eye-piece the extension of the camera would have to be so long as to preclude any hope of reaching the focussing screw of the microscope without some mechanical contrivance. At the same time you can dispense with the eye-piece and use the object lens only, and there are many authorities who advocate this method, but their objections to the use of an eye-piece

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apply mainly to very delicate specimens photographed through high-power lenses such as a $\frac{1}{6}$ or a $\frac{1}{12}$ immersion, and for simple work the eye-piece is an undoubted advantage.

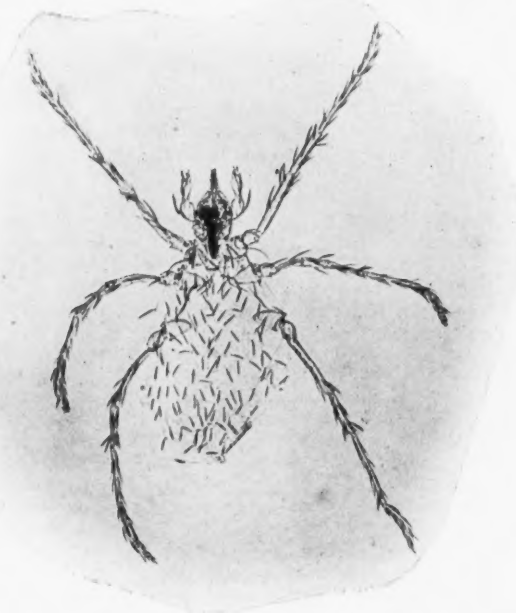
For certain coloured specimens it would be necessary to use colour sensitive plates and screens, but here again you are going into the higher branches of this subject, and for all common objects an ordinary slow plate is all that is necessary. Of course, a slow plate means a long exposure, and thus more risk from vibration; but this question of vibration is not so much to be dreaded when using low powers as might be believed; indeed, all the accompanying photographs were taken on process plates, on the fourth floor of a building that is not far distant from both a railway and electric trams.

[*Photo. by Wheatley Borrill.*

Microphotograph of Foot of a May-fly.

The writer would say, therefore, try slow plates and give a full exposure, but as to the latter nothing definite can be said, since all depends on the light used, the amount of magnification, the density of the specimen, and the opening of the diaphragm. A few words must certainly be inserted here as to diaphragms, as it will be found that with ordinary object lenses the openings provided in most substage diaphragm plates are too big to secure any critical definition, but by replacing the plate by another with smaller openings in it this trouble can be got over; or an iris diaphragm may be fitted.

With regard to a plate with smaller openings, anyone having a few tools and a piece of brass plate can make one for themselves, but the beginner will, of course, try his apparatus before going to this trouble, as his lenses may be so suitable for this work as to require no smaller stops than those in the substage plate. Let it be remembered, however, that the small opening need not be used either in focussing for the eye or for the camera, but merely during the exposure. In working with high-power lenses the heat from the necessarily powerful light often causes trouble, not only by endangering the specimen being photographed, but by the heating of the stage, swelling the metal work, and thus throwing the specimen out of focus; and to obviate this heat filters have to be used. In low-power work, however, there is little or no fear in either of these directions, but at the same time it is as well not to overheat the stage.



Parasite of Garden Spider.

As a choice of subject one would naturally take those that can be examined by transmitted light, and since the photography of all opaque objects, crystals, etc., requires special kinds of lighting, it will not be dealt with in this article, but, at the same time, there are no great difficulties about dealing with opaque substances, or, for the matter of that, with crystals, and any one of the many handbooks on this subject will put the beginner into the right path.

Among specimens, however, that can be examined by transmitted light, many will be found that, while very interesting, will prove too thick for the focus of anything higher than a 1½-inch object lens. Such specimens should not be despised for this reason—a

magnification of only 50 diameters, it should be remembered, does not mean 50 times, but 50 × 50 times; so that a postage stamp enlarged to such a size would look as big as a hearth-rug, and as it would be useless to try to examine micro-organisms with a 1½-inch object lens, or even a ¼-inch, so it would be equally as absurd to look at an unsplit human hair through a $\frac{1}{12}$ inch lens. The subject must, in fact, be chosen to suit the lens, or the lens the subject; and in this matter common sense and experience must be your guide.

The accompanying photographs were taken with a ⅔-inch object lens, and the specimens were those that were found in the trays of the old microscope mentioned above. These specimens were used for this article in order to show not only what may be done with an old-fashioned instrument and lens, but with the slides that can often be found amongst an old collection.

In conclusion it may be remarked that if the beginner has three object lenses, say a ¼-inch, ⅔-inch, and 1½-inch, he will find that for a time, at least, he will not want any higher powers, and that he can obtain some really beautiful and interesting photographs with these relatively low-power lenses. Also with regard to eye-pieces, it is usual to have two or three; not only to obtain various degrees of magnification, but because eye-pieces of a low power are not made to be used with object lenses of a high power. Since, however, the eye-piece is mainly a magnifier and plays but little part in the resolution of the object under examination, it will not be necessary to have more than two of these at first. No mention has been made of capping or uncapping the lens. This can be effected very simply by resting a piece of card between the object lens and the object, which will cut off sufficient light to allow the plate to be uncovered; when, by removing the card, the exposure is begun. During the exposure it is as well that no one should walk about the room, and that the door and, in windy weather, the windows should be closed.

A Fossil of the Future.

IN the *Victorian Naturalist* Mr. D. J. Mahony describes a watch which was found embedded in some recent sandstone at Red Bluff, St. Kilda, and which had been, so to speak, petrified or fossilised by the solution of lime carbonate in the sand. "The specimen consists of a watch and chain, now separate, but evidently once united. The watch is keyless, and the winder has been broken off and is still attached to the chain. The chain is of German silver, and is of the short double type worn by ladies about 15 years ago. The two strands are fastened by a sliding band and the swivel and shank are attached. The ring or bow to which the swivel is fastened is of rolled gold, and the shank which connected it and the winder to the watch has an iron core. The whole is for the most part embedded in a hard mass of sandstone, composed of small silica grains of beach sand and some pebbles of ironstone, bound together by a cement of calcite, and in part iron-stained. The iron oxide is especially common round the steel shank of the winder, from which it has evidently been derived. There are a few slight traces of verdigris on the chain, but the exposed parts scarcely look duller than they would if put by in a drawer for a few years, and they remain quite flexible. It might well be used again if freed from stone. The watch itself was unfortunately broken away from the rock by the workmen who discovered it. Mr. Kosminsky, an expert on the subject, informs me that this kind of keyless movement is still used in Geneva watches, and was first introduced about 20 years ago, so that the age of the watch is restricted to that short number of years. The case is missing, but was probably silver. The works are of steel and brass, and the face is white enamel, quite fresh and unstained, with the figures as clear as on the day when it left the maker. The hands are broken off."

Unfamiliar Eggs.

By PERCY COLLINS.

THE popular conception of what the word "egg" implies is strictly limited. Indeed, the average non-scientific individual's idea of an egg is based, almost entirely, upon what he knows of the eggs of birds. "Do snakes really lay eggs—and if so, what are they like?" The question is frequently put to attendants in the reptile house at the Zoological Gardens. While, should the little captive garden tortoise chance to deposit a dozen or so of its flexible shelled ova, its owner deems the occurrence sufficiently remarkable to necessitate a letter to his favourite morning paper.

But the student of animal life realises at an early stage in his investigations that egg-laying is by no means exceptional; that, on the contrary, and excluding only the mammalian class from the statement, egg-laying is the common rule of reproduction throughout the entire animal kingdom. Further, he soon learns

Egg-Case of Dogfish.

that a preconceived notion of eggs gained exclusively from an examination of those laid by birds is, from a scientific standpoint, absolutely erroneous and misleading. If we take a broad view of the subject we shall be perfectly justified in asserting that the forms of eggs are almost (if not quite) as varied as the forms of the creatures that lay them.

It is proposed, therefore, to call the reader's attention to a few unfamiliar eggs—eggs, that is to say, differing widely in appearance from those objects which have become popularly associated with the name. But before dealing with these curious eggs it may not be out of place to dwell for a moment upon the subject of curious egg layers. Not very many people are aware, for instance, that several members of the great class mammalia—or animals that suckle their young—lay eggs, yet such is undoubtedly the case. These paradoxical creatures constitute two families known respectively as the duckbills and the echidnas, their habitat being Australia and New Guinea. It is supposed that their ancestry can be traced back to certain

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extinct reptiles, the remains of which are found to-day in South Africa. Certain it is that the duckbills and echidnas are the lowliest of all existing mammals, the most striking fact in this connection being that the adults are entirely without teeth, the mouth parts being modified to form an almost bird-like bill.

Duckbills frequent the rivers of Southern and

Egg-Case of Hammer-Headed Shark.

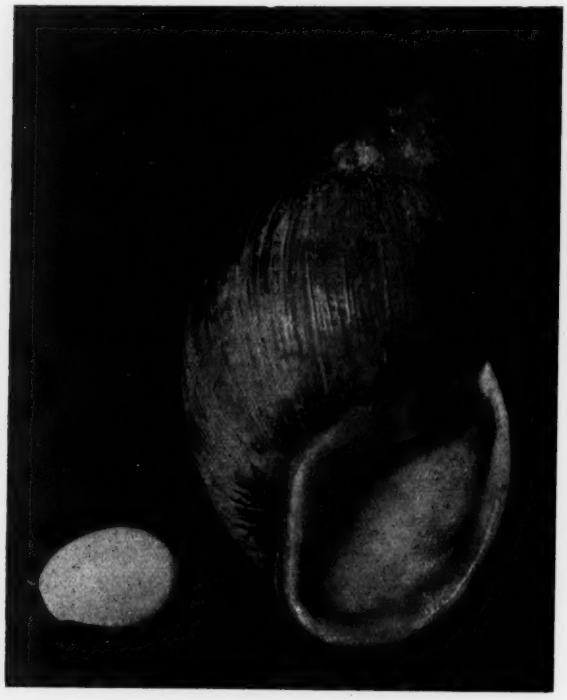
Eastern Australia, and form their nests in holes scooped out in the banks. Here the females lay their eggs, which have flexible shells. Two are deposited, each being about three-quarters of an inch in length. The echidnas occur in New Guinea as well as in Australia. Their habits differ markedly from those of the duckbills, for they are entirely terrestrial, often frequenting arid

Egg Cluster of Cuttlefish—"Sea Grapes."

districts, while the eggs are carried by the female in her abdominal pouch and never deposited in a nest of any kind.

Leaving the mammals we find that all existing birds lay eggs, the ostrich laying the largest. The capacity of an ostrich's egg is about 43 liquid ounces; it will hold about 25 times as much as a hen's egg, that is to say. But the ostrich's egg falls into insignificance when compared with that of the (comparatively) recently extinct *Æpyornis* of Madagascar, the capacity of which is no less than six times greater.

Amongst British birds the little golden crested wren claims the distinction of laying the smallest egg. It is only about half an inch in length, but even this achievement is eclipsed by some of the South American humming birds, the eggs of which are almost incredibly minute. In relation to its size the common cuckoo lays the smallest eggs. For example, the jackdaw and the cuckoo are about equal in size, but the jackdaw's egg is some five or six times larger than the cuckoo's. The relatively largest egg is laid by the kiwi, a curious "wingless" New Zealand bird. The egg is five inches long, although the extreme length of the bird itself is only some twenty-five inches. As a matter of



West Indian Bulimus Snail Shell and Egg.

fact, the bulk of the egg is almost half as great as that of the bird.

Passing from birds to reptiles we find that the eggs laid by these creatures usually approximate closely to the typical ovate or egg-shape. In the case of certain tortoises and turtles, however, we see eggs of a remarkable roundness, those laid by certain species looking for all the world like billiard or golf balls. But the external envelope of reptiles' eggs is invariably pale or white without any of those spots and splashes of bright colour which often render the eggs of birds so attractive.

The ova of frogs, newts, and their allies are usually enclosed in a mass of unpleasant-looking jelly-like substance. The same remark also applies to the eggs of most fishes, yet among fishes we come first upon examples of eggs which take definite rank as unfamiliar objects. To those who are unaware of their origin, many are exceedingly perplexing. Longshore folk

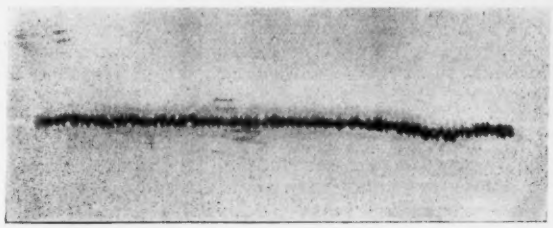
know them by the names of "pixy purses," "fairy purses," or "mermaids' purses," yet very few fishermen can inform the casual enquirer as to whence and how these strange objects come to be cast upon the sands.

These "purses" may be anything from two to five inches in length, and are like little inflated leather bolsters with a long twisted tendril attached to each corner. They are the egg-cases of the dog-fish tribe—voracious fishes of the shark family which prey upon almost any other marine creature unfortunate enough to cross their path. These egg-cases are generally

Egg Cluster of the Common Whelk.

broken or empty, or partially filled with sand when picked up on the shore. In order that the young dog-fish within shall be successfully hatched it is necessary for the "purse" to remain in deep water, securely anchored to the fronds of seaweed or corallines by means of the long twisted tendrils. Thus the developing embryo is kept safe from buffeting and injury; but in very tempestuous weather these cases are often torn from their hold and cast broken upon the shore.

Sharks and their allies the world over lay curious eggs of similar texture and appearance to the kind which has just been described. Annexed is a photo-

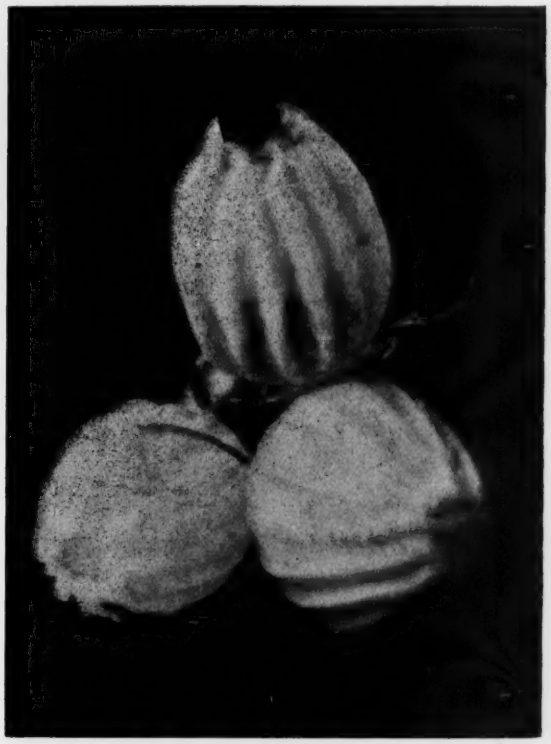


Egg Cluster of Turret Shell.

graph of the egg-case of the hammer-headed shark from Californian waters, taken by the writer from a specimen recently sent to him. In this case it will be seen that the egg is provided with a kind of spiral frill of its own leathery substance. It is attached, when laid, to a frond of weed or sea wrack, and this frill probably assists in keeping it in an upright position in the water.

The sea is strangely prolific in unfamiliar eggs. Those who wander upon the shore must, at times, have noticed clusters of what, at first glance, look not unlike purple grapes. Indeed, these masses are known by the popular name of "sea grapes." Many fisherfolk seem to regard them as some kind of vegetable product—perhaps the fruit of some strange marine plant, but the longshore biologist informs us that these "sea grapes" are nothing more nor less than the egg cluster of the common cuttle—that weird, eight-armed mollusc which disports itself in the sunlit waves to the undoing of incautious fishes. Each "sea grape" is produced with a flexible stalk by means of which the mass is joined together and attached to some stationary object such as a rock or a piece of water-logged timber. But in times of tempest these egg clusters are often torn from their moorings and cast upon the shore.

Shell fish—molluscs, that is to say—lay very varied eggs, only two or three of which can be here described. Many large species of land snail lay white, hard-shelled eggs not unlike those produced by birds. A good



Eggs of a Moth (highly magnified).

example is the species of Bulimus from the West Indies shown in the accompanying photograph, together with its large egg. Quite a brisk trade is carried on in these snail shells and eggs. They are much sought after as curiosities, and although the species is a common one, the egg and shell will command several shillings.

The egg cluster of the whelk (another common object of the sea shore) has been aptly compared to "a rather dingy honeycomb partially squeezed between the hands." This, however, is its appearance when it is found cast high and dry upon the sands. When alive and healthy each egg is semi-transparent, so that the young whelk can be plainly seen through the walls of its nursery. Compared with the size of the whelk, the enormous mass of eggs laid by it seems very remarkable. It is no uncommon thing to find these clusters equal in bulk to both a man's fists.

Another sea egg cluster must be mentioned, namely,

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that of the turret shell—a common rock pool snail. A glance at the accompanying photograph will give the

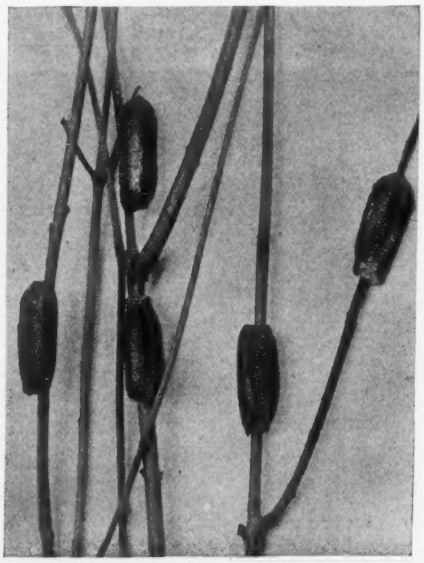
Eggs of Parasite of Reeves' Pheasant (enormously magnified).

reader a good idea of its appearance. The long chain of carefully joined eggs looks exactly like the com-

Eggs of House Fly (highly magnified).

mencement of a necklace cleverly formed, by human agency, of minute portions of rock threaded on a length of silk or cotton twine.

The eggs of insects exhibit a great variety of form and structure and are not seldom extremely beautiful. Generally they are exceedingly minute, needing the microscope to reveal their full loveliness. The eggs of the common house fly, which are usually deposited in excrementitious matter, exhibit a marvellous lace-like beauty when highly magnified. Nearly all Lepidopterous insects (butterflies and moths), too, lay eggs which well repay microscopical examination. But, per-



Egg-Cases of a Mantid or "Rearhorse."

haps, the most charming of all insect eggs are those of the tiny lice, or parasites, which frequent the feathers of birds. These eggs are apt to remind the experienced microscopist of the minute flinty shells formed by the lowly marine forms of life grouped under the names Polycystina and Radiolaria. They are like dainty little fairy caskets, each with an accurately-fitting lid, covering the aperture through which the new-born insect will emerge into its world of feathers. The eggs of the parasite of our common fowl are beautiful, but those of certain species which frequent the feathers of foreign birds are even more striking.

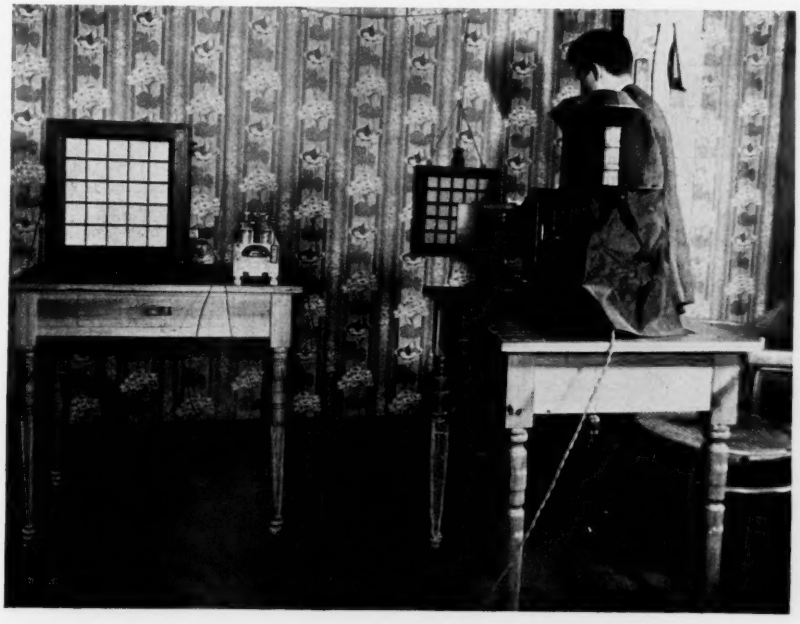
The egg clusters of insects are not invariably minute. The curious "praying mantids," or "rearhorses," as they are called across the Atlantic, deposit their eggs in masses upon the twigs of trees and bushes. Upon close examination these egg clusters have a strange, braided appearance, but when viewed from a distance they are not unlike so many seeds or pods.

EXPERIMENTS were recently made in France on various preservatives of wood, including carbonileum Avenarius, carbonileum Lyon, gas tar, microsol, lysol, antimony, antigermine, and hydrofluoric acid. It was found that for spruce, beech, poplar, oak, and Aleppo pine, exposed to the atmosphere, the best preservatives are certainly the carbonileums, gas tar, and microsol. The other substances examined produced absolutely no effect. These same preservatives (carbonileum, gas tar, and microsol) are also most efficacious for the preservation of wood in the confined hot air of mines. Antimony and hydrofluoric acid are less effective.

First Actual Solution of the Problem of Tele-Vision.

By DR. ALFRED GRADENWITZ.

THE problem of tele-vision has long been a favourite one with enterprising inventors; a large amount of ingenuity has been bestowed on attempts made to solve it. Thus, those many examples of tele-photographic apparatus which have been made known in the course of the last few years are mainly the outcome of such endeavours. In fact, the transmission of photographs, drawings, and handwriting over a telegraph wire, giving a reproduction at the remote end, is incomparably more easy than the instantaneous rendering of the moving objects situated at the transmitting station.



Mr. Ruhmer's new apparatus for transmitting light by selenium cells.

A solution of the problem could, it is true, be attempted on the very principle underlying the construction of these tele-photographic apparatus. What would be required is that the various sections of a picture be reproduced—not successively, as in the case of tele-photography, but simultaneously, as well as instantaneously, without any lag, becoming visible immediately without any photographical process. Now there were, so far, two difficulties in the way of a practical realisation of this idea, viz.: (1) The costliness of such an outfit; (2) the sluggishness or *inertia* of the vital organ of most systems—the photo-electric selenium cells.

Mr. Ernest Ruhmer, of Berlin, well known by his inventions in the field of wireless telephony and telegraphy, has succeeded in perfecting the first demonstration apparatus which may be said actually to solve the problem. The writer has had an opportunity of inspecting this curious machine immediately before its being sent to Brussels, in order there to be demonstrated before the promoters of the Universal Exhibition planned for next year. In fact, a complete and definite tele-vision apparatus, costing the sum of £250,000 is to be the "clou" of this show. The demonstration apparatus has been produced at a cost of £250, and owing to its more elementary construction only lends itself to the reproduction of simple patterns, consisting of squares arranged in different combinations. Fig. 1, representing the inventor with his apparatus, will make the meaning of this clear.

Mr. Ruhmer is seen standing beside a projection apparatus, throwing the pattern on a screen hung up on the wall, which screen is a square divided into 25 square sections.

Behind each of these sections is arranged a highly sensitive selenium cell in which, by a novel process, *inertia* has been absolutely eliminated. It thus responds instantaneously to any variation in lighting it is exposed to.

At the receiving station is arranged a similar screen, divided into the same number of sections, each of which communicates with the corresponding section on the transmitting screen. While the actual system used in transmission is kept secret, this much may be stated, that a highly sensitive mirror galvanometer reconverts the fluctuations of current produced by fluctuations in luminous intensity on the transmitting screen into corresponding light variations. To the right of the receiving screen is seen the accumulator battery, supplying the current to the tele-vision circuits.

As soon as a perforated pattern is inserted into the projector, a telegraphic reproduction of the picture is seen to appear at the very moment it is thrown on the transmitting screen. The sluggishness of the cells has been compensated to such a degree that the telegraphic picture will respond practically instantaneously to any motion. In fact, a reproduction obtained at most in a few minutes with the photo-telegraphic apparatus so far constructed is here achieved in a fraction of a second, so that several phases of a motion can be reproduced within a second.

It is hard to realise what sum of laborious work had to be expended in constructing even this relatively simple apparatus. In fact, each section, with its selenium cell and mirror galvanometer device, is an apparatus of precision in itself, while the definite apparatus will be composed of 10,000 elements of the same kind. Each selenium cell will have to be wound personally by the inventor, who never entrusts his work to anybody else.

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The Graphic Representation of Harmonograph Curves.

By CHARLES E. BENHAM.

(*Continued from page 270.*)

It was mentioned in the previous chapter on the above subject that the method described for plotting the curves of two compounded circular movements was equally applicable for those compounded of elliptical movements.

This may now be demonstrated with examples which will render the matter clearer and will show how, by tracing a pair of twin-elliptic curves representing the same harmony in a slightly different phase, interesting stereoscopic effects are obtained. These are not obtainable with a pair of twin-circular curves. The twin-circular curve does not change its form at all with change of phase. Its position is all that is altered, a circumstance arising from the fact that the divisions of the circle are of equal length. Divisions, on the other hand, of an ellipse or of a straight line, representing equal time-fractions of the total period of oscillation,

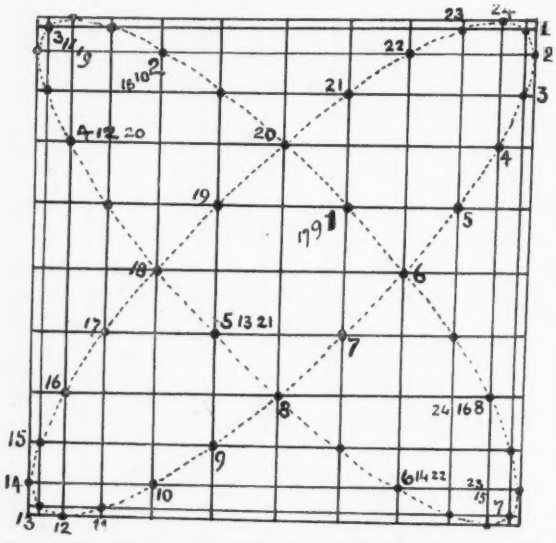

Fig. 1.—Two ellipses set at right angles and divided into equal time intervals, ratio 1 : 3 opposed rotation.

vary in length, and, consequently, differences of phase alter both the form and the position of the resultant curve, a slight phase-difference giving figures that form a stereoscopic pair.

To describe the method of producing such a pair we must revert to the diagram already given showing a square divided into what were called "squares of equal time." Placing on this groundwork dots as shown in Fig. 1 two ellipses are marked out at right angles with each other, with their orbits divided into 24 divisions, each one of which is traversed by an elliptic pendulum in the same time, that is, in one twenty-fourth of the total time taken to traverse the complete orbit.

To trace the curve of, say, a 1 : 3 harmony, compounded of these elliptical movements in opposed rotation, let the dots of each ellipse be numbered from 1 to 24, one clockwise the other counter-clockwise, the spaces between the numbers embracing only one division in one case and three divisions in the other, as shown in Fig. 1 and again in Fig. 2. Bisect the line joining each pair of points, and the curve required will be produced by joining up the points of bisection, as represented in Fig. 2. To show the same figure in slightly different phase repeat the operation, only this time the line bisected must be that between 1 and 2, 2 and 3, and so on, instead of between 1 and 1, 2 and 2, etc. The bisections are easily made with a pair of dividers, a straight edge being laid on the paper at the same time to show the position of the line between the pairs of points.

The second curve thus produced is shown by the dotted line in Fig. 2, and the two curves form a stereoscopic pair.

To show the stereoscopic effect lay a thin sheet of paper

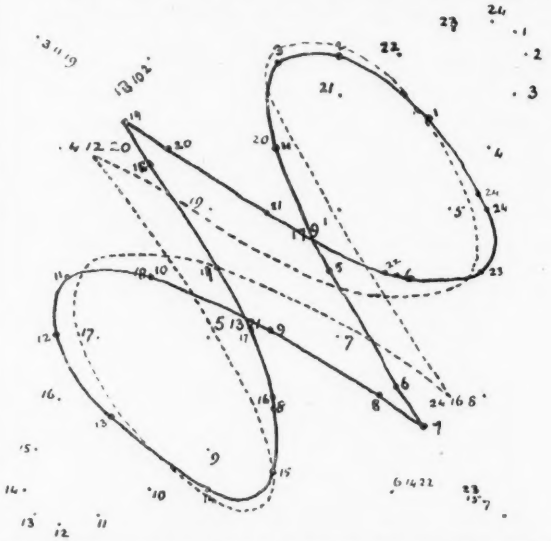

Fig. 2.—Stereoscopic pair. Ratio 1 : 3, opposed rotation. To be traced in red and green respectively. The tracing must be held with the pointed extremities vertical and viewed through spectacles having one eyepiece red and the other green.

over the illustration, and trace the two figures carefully, one in pale red ink the other in pale green, letting the pair intersect as in the diagram. Now, holding the tracing with the pointed extremities of the figure vertical, view the coloured images through spectacles of coloured gelatine

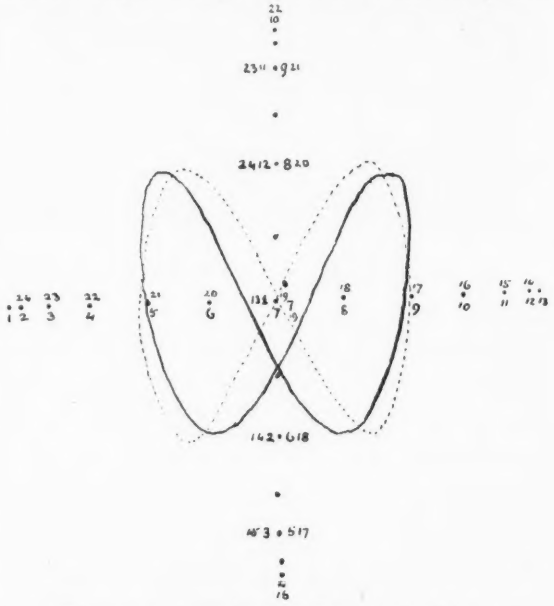

Fig. 3.—1 : 2 rectangular oscillations, stereoscopic.

—red for one eye, and green for the other—taking care that the colour of the gelatine matches the ink. A single figure, forming a strikingly solid curve, is seen.

Other phases and other harmonies can be similarly treated, and an almost infinite number of stereoscopic curves

can be traced representing various combinations of twin-elliptic motion.

By placing numbered dots either along the diagonals of the square given in Fig. 1, or along its central vertical and horizontal lines, and bisecting the lines joining the pairs of points, the method is equally applicable for the curves of compounded rectangular oscillation, and these may be similarly traced stereoscopically, by introducing a slight difference of phase into one of the two tracings (see Fig. 3, which shows a 1 : 2 harmony traced as a stereoscopic pair). The groundwork of equal "time squares" in Fig. 1 can, therefore, be used for plotting out by the simplest possible means curve harmonies of practically any kind, that is, those compounded by either rectilinear, circular, or elliptical movement in various phases and in various amplitudes, and the inclination of the two movements may be either rectangular or at any other angle.

It will be realised that by the aid of the groundwork of squares many combinational curves may be traced that are not obtainable with the harmonograph. For example, the

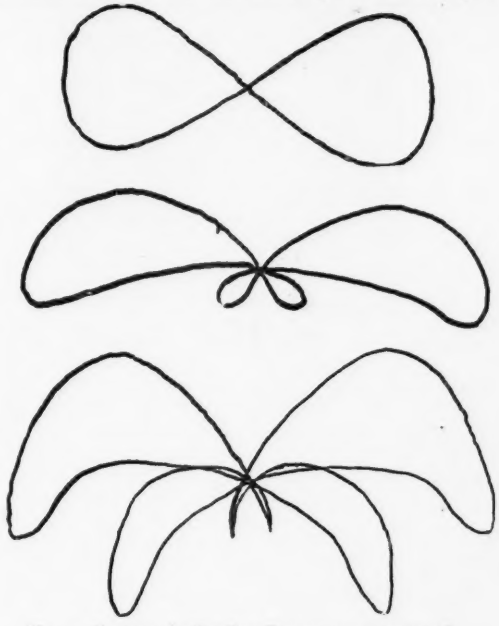

Fig. 4.—Compound vibration figures, arc movement.

curve may be produced that would result if, instead of compounding two straight lines, the arcs of circles which the pendulum extremities actually describe were combined. Two arcs set at right angles with each other thus, (⌒ necessarily give a very distorted curve, a circumstance that has puzzled more than one experimenter with the harmonograph who has tried to produce tracings on a wall surface by means of two pendulums swinging on the surface of the wall with arm attachments to produce rectangular movement. In such cases the curve is obviously the result of compounding two arcs instead of two straight lines, and the effects are very distorted and disappointing. But if the arcs are not placed in the unsymmetrical relation (⌒ but symmetrically, thus, ⋋ some interesting harmonies will be found to result from compounding their movements. The unison curve becomes a figure-of-eight form instead of a circle, while the 1 : 2 and 1 : 3 harmonies give the strange butterfly-like winged figures shown in Fig. 4.

The formula for plotting out the curves resulting from the compounding of two circular movements is a very simple one. A circle is divided into any convenient number of equal parts, say 24, and these are numbered from 1 to 24 on the outside of the circle. They represent units of time, in this case proportionate to the units of space traversed. The units of the second circular movement are numbered, for convenience, on the inside of the circle, and, supposing the harmony to be a 1 : 3, must be each three times as long as the other units; if a 1 : 2 harmony twice as long, and so on. The two series are numbered in the same direction round the circle for concurrent rotation, and in opposite directions for antagonistic rotation. Then, taking a pair of dividers, open them to the distance between the two 1's, and strike an arc from each 1 as centre. The intersection of these arcs is point 1 of the required curve. Separating the dividers to the distance between the two 2's and again finding the intersection of arcs from these centres, point 2 of the curve is found, and so on with all the 24 pairs of numbers.

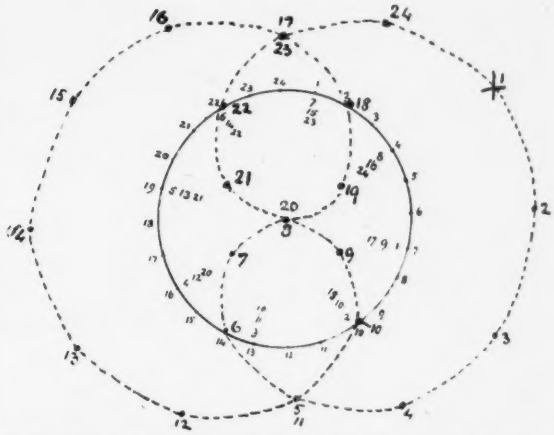

Fig. 5.—Method of plotting out twin-circular curves, 1 : 3 Harmony concurrent.

Fig. 5 shows the 1 : 3 curves in concurrent rotation. The phase is dependent on the relative positions of the starting points of the two series of numbers. The diagram assumes the two movements to be of equal amplitude, the same circle being used in the construction for the two movements. To represent the curve resulting when the two circular movements are of different amplitude, two concentric circles are made, and numbered separately, the inner one representing the smaller amplitude. The method of plotting the curve is the same as in the case of the single circle with its double numbering.

The construction of these curves brings to light the causes of the varieties of form in twin-elliptic pendulum harmonies. It will be found, for example, that when the internal nodes exactly meet at the centre (as in the figure) the amplitudes of the two elements are equal. An increase of amplitude in the slower of the two movements withdraws the nodal extremities apart and from the centre, while if it is the other pendulum that has the larger amplitude the nodes will reach beyond the centre and overlap. Other modifications are brought about by difference of phase, and, of course, by the circumstance that the movements compounded are more often elliptical than circular.

A NEW kind of glow in vacuum tubes has been discovered by the Rev. H. V. Gill, S.J. A vacuum tube is fitted up containing a small strip of palladium foil, or platinum foil coated with palladium black, mounted at the extremities of two leads, so that its temperature can be raised by means of an electric current. When the foil is heated in air at a pressure of about 0.15 millimetre to a white heat, there becomes visible round it a glow, not unlike the "negative glow" in a vacuum tube discharge. There is, however, no electric field except that due to the current employed to heat the foil. The glow is a rich purple-blue colour, and is separated from the hot palladium by a dark space. There is evidence that the luminosity is due to a complicated reaction between the gases in the tube and particles of the disintegrated palladium.

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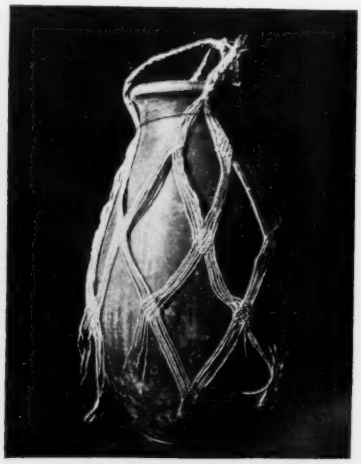
Memphis and Qurneh.

Professor Flinders Petrie's Excavations.

THE year's work of the British School of Archæology in Egypt, the results of which have been exhibited during July by Professor Flinders Petrie at University College, comprise two discoveries which are of very great and conspicuous interest. The first of them is the content of a burial which was found in the valleys to the north of the tombs of the kings (Thebes), and which Professor Petrie describes as probably the richest entire burial that has been brought from Egypt. The date of the Qurneh burial is XVIIth Dynasty (about 1600 B.C.), and the tomb was in a shallow rock trench, covered only with a foot or two of stones and sand, and situated in a remote corner of a branch valley.

The exterior of the tomb, showing the jars strung on a pole.



One of the jars with its net of string-work.

Dates and Grapes in the earthen vessel, and other provisions found in the tomb.

The coffin is hewn out of a single block. It is decorated with gilded wings that are painted in blue and black. The body has become mere dust; the bones are almost perfect still. At the foot of the coffin is a smaller box coffin in which was buried a child, and with the child was found its necklace of gold beads. By the side of the coffin was a row of vases slung on a stick, their original string work beautifully preserved after the passage of more than three thousand years. The string work is beautifully regular, as may be seen from the photograph. This photograph, together with the others that we publish, we owe to the great kindness of Professor Flinders Petrie.

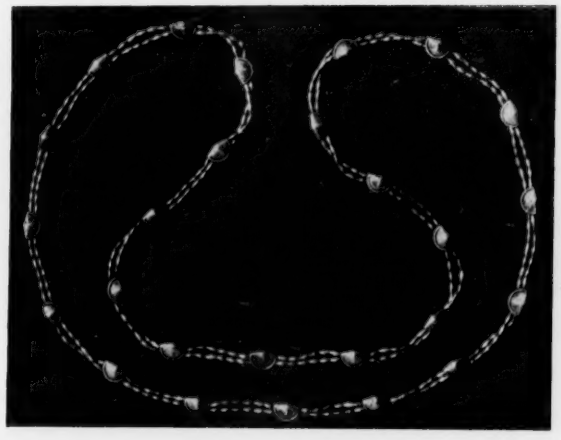
The vases, rare and beautiful as they are, do not exhaust by any means the interest and value of this burial. The Egyptian lady who was laid in this rocky tomb must have been a person of wealth and importance, though, rather curiously, the inscription on the coffin is only a formula, without name or title. The jewellery buried with her is both costly and fine. The collar of gold consists of four strings, each of about four hundred rings; these are united by two end pieces, each of which bears four small eyes, and held together by a gold pin. There are earrings and armlets of gold, and a girdle of electrum (gold and silver alloy). The girdle was round the waist of the body, and it is made in imitation of a string of seeds and discs. An oval electrum pin fastened the neck of the grave clothes, and on the third finger of the left hand was the green scarab with *nofer* and scrolls.

At Memphis, in the northern part of the ruins, the greater part of the palace of Apries was disclosed. This XXVIth Dynasty palace covered two acres, and its walls, which, as the columns show, once rose to forty or fifty feet, are still some ten to fifteen feet high. In the fosse which defended the palace the blocks of a great portal were found, and on these blocks were sculptured in low relief of great delicacy scenes of kingly and princely festivals. But this portal belongs to the XIIth Dynasty, and from its portraiture Professor Petrie surmises that the scenes it represents are those of the appointment to the position of Crown Prince in 3434 B.C. of Senusert I. Many of the palace walls descend far below the floor of Apries, and this XIIth Dynasty stone portal shows that many earlier palaces probably lie in the fifty feet foundations. The halls and

court of Apries were fitted into the ruins of walls which had fallen into decay since the site was deserted on the founding of Alexandria. One of the most beautiful

Toilet articles, including a beautifully carved stone dish—in which figures of monkeys climb the sides—and a Kohl-pot.

objects here found was a piece of gold and silver work (retained by the Cairo Museum), which was probably an ornament of a kingly palanquin, and represents the



A girdle of electrum.

head of a goddess. A large quantity of bronze and steel was found in the palace, and some fragments of scale armour.

A VERY interesting electrical clock was exhibited at the Southern Electrical and Industrial Exposition held in Louisville, Ky. This clock is different from the ordinary in having no hands. Minutes are indicated by means of sixty radial rows of lights, each containing 32 electric globes. The hours are indicated by shorter rows of coloured lights. In place of the hands, then, two lines of light sweep over the face of the dial, one indicating minutes and the other hours. Each second the illumination in an outer circle of lights moves forward one lamp, and when an entire circuit has been completed, the row of minute lights is advanced one interval. The hour hand moves at five-minute intervals. The dial is formed on the face of a huge pendulum, which swings to and fro over an arc of 15 feet. The pendulum is 48 feet long, and its weight, with the 5,485 lamps and 11,000 connections required, is 3,000 pounds. Over a mile of wire was used in making the connections of the clock.

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Light Standards. Although, for two or three reasons, a definite standard of light is not of so much importance in photography as in connection with problems of illumination, it is becoming increasingly desirable, as photographic methods are becoming more exact. It is satisfactory, therefore, to know that the official photometric standards of Great Britain, France, and the United States of America have, by a little adjustment, been made identical, and it is hoped that the uniformity of this "International Candle" will be maintained. The "Pentane candle," the "Bougie decimale," and the "American candle" are now identical in illuminating power, and are equal to 1.11 "Hefner unit" or .104 "Carcel unit." The Hefner unit is just nine-tenths of the "International candle." It will be understood that the use of the term "candle" does not at all imply that a candle is used, but that it is only the name given to a certain unit of illuminating power. It does not matter for photometric purposes whether pentane, amyl acetate, colza oil, or an ordinary candle is burnt, so long as the light produced is uniform and bears a known relationship to the adopted standard. But it does not at all follow that uniformity in photographic action results because uniformity of illuminating power has been secured. Indeed, we can go further and say that the equal action of two sources of illumination upon a given sensitive material is no proof whatever that the same two illuminants will have an equal action on some other sensitive material. For photometric purposes it is only the luminous rays, the rays that cause ordinary objects to be visible, that are considered, and the problem is simple compared with the needs of the photographer who is concerned with the radiations of every kind.

The Estimation of Sensitiveness. It is the fact stated at the end of the last paragraph that is the fundamental difficulty with regard to the estimation of sensitiveness. The wish that is so often expressed to have the comparative sensitiveness of various materials exactly expressed can never be gratified, because sensitiveness is not an absolute quality of the material, but depends also on the nature of the radiant employed. It does not follow that one plate is twice as fast as another to daylight because it is twice as fast to candle light or to any other light. Indeed, the proportional sensitiveness of two plates to daylight is not constant, because daylight itself varies, and a plate that is faster than another at mid-day may become slower than the other towards evening, because of the change in the quality of the light. An approximate indication is, therefore, all that is possible, and this, if carefully made, will be distinctly useful. At the same time I would not have it thought that the indications that makers give of the sensitiveness of their products might not often be made very much more useful than they are, especially when they relate to materials of the same kind which differ presumably in little else than sensitiveness. But *exact* estimations are impossible except under exactly prescribed conditions, and then will only hold under the same conditions.

Photographic Scale Reading. Those who do much work with instruments, such as polarimeters, where the setting of the instrument alternates with the reading of the scale, will appreciate any attempt to reduce the strain on the

eye which is increased by the fact that the critical observation of a, perhaps, feebly illuminated field is always preceded and followed by the reading of a more brightly illuminated and finely divided scale. J. R. Milne (Proceedings of the Royal Society of Edinburgh, 29, 176) has sought to relieve the eye and at the same time ensure a more accurate and unbiassed reading of the scale, by photographing the vernier and scale after each setting. The instrument is arranged so that the vernier is fixed and the adjustment made by moving the scale, and opposite the vernier is a camera that carries a 5 × 4 plate upon which the image of the vernier is focussed once for all. The plate is shifted by simple means after each exposure. Each plate will receive sixty records, six rows of ten each, and a single or double wedge-shaped impression can be made whenever desired, for identification purposes—as to indicate the beginning of a new series. Whether or not such a method of work will prove acceptable to those most interested can only be determined by experience, but even if the method is not generally appreciated, all attempts to save the eyes and enhance the accuracy of observations are praiseworthy.

Bleach-out Printing Paper. The three-colour bleaching-out paper known as "Uto" is still occupying the attention of Dr. J. H. Smith. He states in a recent number of the *British Journal* that he has found a new sensitiser which is odourless and "enormously quicker" than any hitherto published. It will render the paper "quite double the speed of P.O.P.," and enable the paper to be used in the camera with, of course, a prolonged exposure. It will reduce the time of printing in the shade from "days in dull weather to minutes." Investigation is also proceeding with regard to desensitisers, which are needed not only, as far as possible, to render the final print stable, but also to regulate the bleaching of the individual colours, that they may bleach out at the same rate.

A Photographic Lamp, etc. Mr. Albert J. Garrad, of 317, High Holborn, has recently introduced a lamp suitable for enlarging, photomicrographic, and other projection purposes, that is entirely self-contained and very simple in construction and use. It takes an ordinary incandescent mantle, and this is heated by the combustion of petrol vapour. The petrol chamber is a small rectangular vessel, and is filled with a porous brick which is charged by being saturated with petrol. Thus there is no liquid about the apparatus that can by any means be spilt. By opening the apertures in the chamber, enough air charged with petrol vapour passes along the short pipe that leads to the burner to start the flame, and the flame immediately makes a draught that draws more air through the chamber, and will give a flame much larger than is desirable. By merely turning a screw that reduces the opening the flame is regulated with precision. The lamp cannot fail to be appreciated by anyone who wishes his projection apparatus to be independent of gas and electric fittings. Mr. Garrad has also a well-designed leg to support a telephoto. lens when the camera is extended too much for the ordinary tripod to hold the camera rigidly, an enlarging lantern that embodies some good practical points that are too rarely met with, a combined colour screen holder and exposing flap which takes the place of the lens cap, and one or two other items of essentially practical apparatus.

The Developable Image. Last month, under this heading, I ascribed to Dr. Lüppo-Cramer the discovery that the latent image produced by Röntgen rays may be made visible or "developed" by simple exposure to daylight or artificial light. From another communication of Lüppo-Cramer's it appears that R. Luther and Uschkoff made this discovery, and that Lüppo-Cramer confirmed and extended it. Electric sparks will give an image that may be similarly "developed," and it depends upon the character of the plate whether such "development" is possible. Lüppo-Cramer got the best results with Schleussner's bromsilver transparency plates.

Solar Disturbances During June, 1909.

By FRANK C. DENNETT.

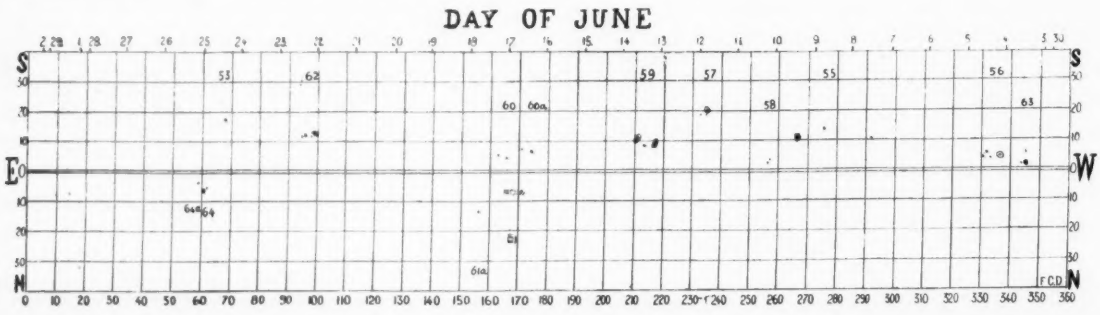
THE month of June has again yielded a lower number of disturbances, although some broke out with considerable rapidity on the visible hemisphere. The longitude of the central meridian at noon on June 1 was 17° 51′.

No. 53 is repeated from the previous chart, having remained visible until June 2.

No. 55.—A spot, 7,000 miles in diameter, rapidly declined and disappeared, June 3 to 6.

No. 56.—On 3rd an area was noted wanting in definition, but at best moments containing pores. On morning of 4th a spot was seen with a tiny companion. By afternoon the spot had increased to 12,000 miles in diameter, later increasing to 18,000 miles, spots eastward bringing the length of the outbreak to 64,000 miles. It displayed a considerable amount of activity and was last seen on 10th.

No 57.—First seen as a spot near the limb on 6th, alone until 11th, when its penumbra considerably increased towards north-east. Pores in the same direction on 12th, one remaining until 14th, the spot dwindled until 17th, its maximum diameter was 15,000 miles.



No. 58.—At first one, and later two or three tiny pores in a brilliant area, only seen on 14th.

No. 59.—A disturbed looking area on 13th showed two pores. On 15th it broke into a ring group, the preceding and following members increasing within a few hours to 22,000 miles in diameter, the length of the disturbance being 60,000 miles. On 17th the inner border of the penumbra of both the spots was noted as being fringed brightly. Both spots retained a considerable size until they passed round the limb on 20th.

No. 60.—A pair of pores 15th and 16th, but when last seen on 17th only the western pore remained, with a close companion. The total length was 26,000 miles.

No. 60*a*.—A somewhat similar pair, at the same distance apart, seen on 16th and 17th, whilst on 18th only one minute pore remained. Not seen after.

No. 61.—An area showing a rugged character on 15th, containing two pores on 17th, which within a few hours had assumed a partially elliptical form. The group was protean in appearance, with a total length of 52,000 miles, but only a solitary pore remained on 21st. On 22nd a tiny pair of pores showed just north-east of the group's place until 23rd.

No. 61*a*.—A pore seen on 22nd and 23rd.

No. 62.—A group of three pores on 21st ranged N.E. to S.W. On 22nd the south-western, or leading spot had increased considerably, with an oval group of pores. The leader reached 14,000 miles in diameter and the group 48,000 miles in length. The axis of the group assumed a direction more nearly parallel to the sun's equator. Only the leader remained on 26th, but it had a tiny companion on 27th. When last seen on 28th, there was a bright bed of faculæ surrounding it.

No. 63.—A single spot 15,000 miles in diameter, seen June 25 to July 6. On 28th and 29th its penumbra had the inner border fringed brightly whilst a tiny companion was closely behind it.

No. 64.—A spotlet developed on 26th with two pores near by, others were visible on 27th, giving a length of 37,000 miles. On 28th only one pore seen, and on 29th two pores showed a little north-east.

No. 64*a*.—A new pore broke out on 29th, but not seen again.

The chart is compiled from the observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and the writer.

Star Mica.

By CHARLES E. BENHAM.

ONE of the curiosities of mineralogy is the phenomenon of asterism, the optical peculiarity of certain rare crystals that exhibit a star-shaped figure when light from a defined source is reflected from them or transmitted through them. Examples of asterism are met with in the star stone, or asteriated sapphire, which, when cut and viewed in a direction perpendicular to the axis, reflects light in the form of a star; and also in the star ruby which shows the same effects. The phenomenon in these cases is due to twin lamellæ symmetrically arranged. The asterism of star mica is best seen by transmitted light. If a piece of the mica is held between the eye and a lamp in an otherwise dark room a brilliant six-rayed star is seen radiating from the luminous centre as in the illustration, which is a photograph of a lamp flame taken with an ordinary camera having a strip of the star mica placed in front of the lens. As the mica is rotated while looking through it at the lamp the star turns with it. It will be noticed that between the six rays are six fainter radiations. To all appearance the star mica resembles ordinary mica, and it shows just the same phenomena of polarisation. Under the microscope, however, it will be seen that it is traversed by numerous fine needles of some mineral, pronounced to be akin to tourmaline

Photograph of a lamp flame taken at a distance of about 15 feet with a strip of star mica fixed in front of the lens. Exposure 5 minutes. The illustration represents exactly the effect seen when the lamp is viewed with the eye through the star mica.

or rutile, the needles being regularly disposed at angles of 120 degrees. To this the asteriated image of the transmitted light is due. Star mica has been found in the northern portion of New York County, and at Burgess Hill, Ontario, Canada. The subject of asterism will be found discussed in Miers's Mineralogy and in Dana's Text-book on Mineralogy.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S., F.R.A.S.

SIZES OF PHOTOGRAPHIC STAR IMAGES.—A very important point to be considered by all who employ photographic methods for registering star images, to determine magnitudes, etc., is the degree to which the diameter of the developed image is affected by other factors than the true dimensions of the projected image. Prof. C. D. Perrine has been investigating this matter closely at the Lick Observatory, and finds rather interesting variations depending on both instrument and the wave-length of the light employed in making the image. The sizes of photographic star images produced by telescopes of ordinary aperture and of focal lengths of 20 feet or less, under good atmospheric conditions, are reasonably small. With greater focal length, however, the spreading of the light rapidly increases the size of the images until, with instruments of 50 feet focal length or over, it is necessary to give greatly increased exposures to produce measurable images on the sensitive film. With such telescopes, of aperture, say, from 36-40 inches, it is impossible to obtain images of stars of 15th or 16th magnitudes, with reasonable exposure times; while with similar aperture and focal length under 20 feet, images of 17th and 18th magnitude stars are secured with one hour's exposure under ordinary conditions

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of steadiness and transparency of atmosphere. This increased blurring with long-focus instruments not only enlarges the star images and greatly increases the exposure times, but in the case of planetary and lunar photography it destroys the finer details.

In the case of large refractors some degree of improvement in the definition of the images has of late years been obtained by the use of colour screens, and it has generally been thought that the consequent increase of sharpness is due to the elimination of the secondary spectrum. Prof. Perrine now thinks that this is not the chief cause of the improvement. Starting on the assumption that as the rays composing the star image must be disturbed by the atmosphere, it is most probable that the longer waves will be less disturbed than the short ones. To test this a special series of exposures were made with the newly-modelled Crossley reflector, giving four plates of the same field of stars, on the same evening, within 15° of the zenith, all with the same exposure, using (*a*) the ordinary actinic region of the spectrum from λ3000-λ5000; (*b*) the greenish-yellow region from λ4700-5700. A comparison of the plates shows that for a given intensity, the images are smaller and sharper on the isochromatic plate, the ratio being about 1 : 2. On then calculating the atmospheric dispersion for the minimum effective wave-length in the two cases, λ3800 and λ4800, it is found that the image given by the shorter wave-length would be about 2.5 times that formed by the longer waves, and this is in fair agreement with the actual ratio found by observation. The general result of the investigation, therefore, is that photographic definition of stars or planetary detail is largely a matter of the wave-length of the light used in forming the image; for bright objects, such as the sun, moon, planets and bright stars, photographs obtained in red light on specially sensitised plates, using a red colour screen, will be much sharper than those obtained on ordinary plates. —(*Lick Observatory Bulletin*, No. 154.)

MEASUREMENT OF CHANGES IN THE SUN'S DIAMETER.—Some years ago C. L. Poor made a long series of comparisons of various measures of the sun's diameter with the object of determining if any change could be detected, but the conclusions were not sufficiently definite to favour any positive assertion as to the actual effect. In the summer of 1907 a new method was devised, whereby two photographically corrected lenses of 25 feet focal length were arranged side by side so that the projected images partly overlapped. The mounting of the lenses was arranged so that they could be rotated to bring the intersection of the images along a polar or equatorial diameter. Two methods of reduction of such photographs are possible; (1) by measuring the width of the overlapping lune, thus obtaining directly the length of the diameter passing through the centres of the two images; (2) by measuring the length of the common chord of the two images. This latter method is very sensitive, as any very slight changes in the diameter of the image produce large changes in the chord. The only drawback to the method is the fact that refraction corrections have a considerable effect, and special formulæ must be used for reduction. To eliminate the effects of atmospheric disturbances in impairing the images, it is necessary to take several plates and mean up the results. The author gives the method of deriving the necessary refraction formulæ, and also an example from actual plates taken at the Yerkes Observatory, from which it was concluded that the equatorial radius exceeded the polar radius by 0″.57. Several difficulties inherent to long focus mountings are discussed, and a suggestion is made that some form of telephoto combination might give satisfactory results.—(*Astrophysical Journal*, Vol. 29, p. 313, May, 1909.)

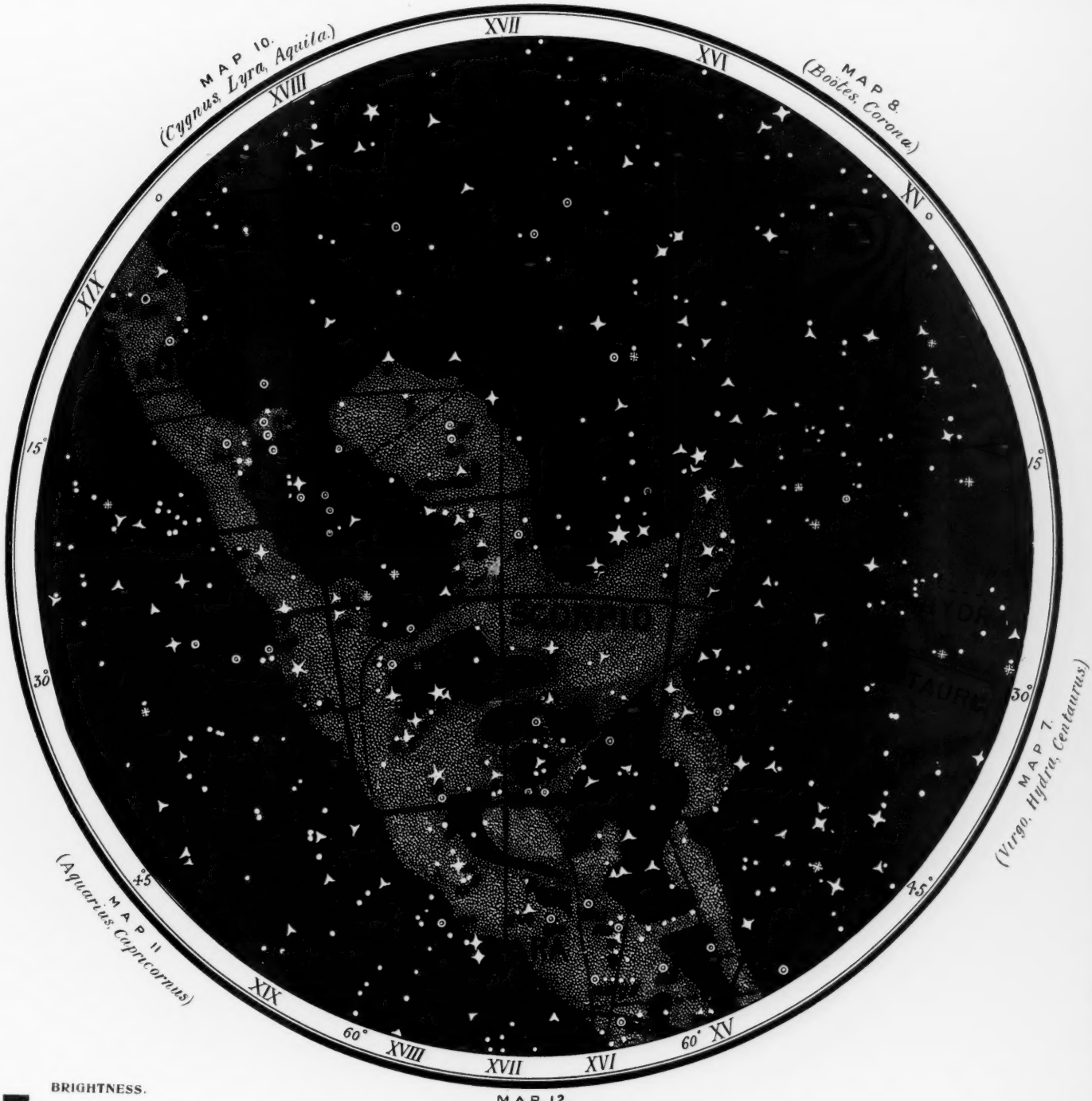
ATMOSPHERIC TRANSMISSION BY NIGHT AND BY DAY.—M. Ch. Nordmann, of the Paris Observatory, announced some time ago that he had obtained evidence that in many cases, especially when it is very clear, the distribution of atmospheric absorption in the spectra of the stars appears to be notably different from what it is when studied in the solar spectrum by day. Generally he found that for zenith distances less than about 70° (beyond this point the phenomena of absorption return to the normal type) the violet and blue parts of the spectrum are less absorbed at night than by day, and further, that in some cases, this violet region is less absorbed than the red part itself. From this he concluded that the atmospheric absorption is different at night from what it is in the daytime.

Professor F. W. Very does not agree with this explanation. Admitting that the actual observations may be satisfactory, he suggests that the differenees found may really be due to the varying sensitiveness of the eye according to whether it is subject to strong or weak lights. Thus at night time, in feeble light, the eye is much more sensitive to violet light than by day. It may thus happen that differences in the distribution of the more intense groups of absorption lines, such as occur in the spectra of stars of various types, may shift the point of maximum brilliancy into regions of the spectrum for which the eye has very diverse degrees of sensitiveness. A comparatively slight change in the wave-length of the ordinate of maximum brightness in the spectral luminosity curve, due to the absorption of the rays by the atmosphere of either the star or the earth, may thus correspond to a much more considerable change in the star's apparent brightness on account of the unequal sensitiveness of the eye to the combined rays, when those wave-lengths to which the eye is specially sensitive are either deficient or present in excess. Thus the change of apparent brightness for the same difference of altitude may vary considerably in the case of two stars whose original light distribution is not the same in the region of the spectrum which chiefly contributes to the visual impression. It is also evident that much larger charges in other parts of the spectrum, such as the violet, which undergo strong absorption, but do not affect the eye much, will have relatively little effect on the apparent magnitude of the star obtained by eye estimate. From these arguments Prof. Very concludes that the apparent increase of atmospheric transmission of violet rays at night is to be explained by the application of physiological phenomena.—(*Astrophysical Journal*, Vol. 29, p. 325, May, 1909.)

SEARCH FOR PLANET BEYOND NEPTUNE.—Professor W. H. Pickering writes to the July issue of the *Observatory*, giving some particulars of his programme for continuing the search for the suspected planet beyond Neptune during the coming year. The region so far examined extends for 25° along the ecliptic, and although it is all but certain that the planet exists, and its longitude known with sufficient accuracy, the fact of its having a very small mass precludes any practical method of determining its latitude. It is proposed, therefore, during the next winter to search for 15° or more both north and south of the ecliptic.

RADIAL MOTION IN SUNSPOTS.—Mr. J. Evershed makes further mention of details noticed by continued experience with the phenomena he has charactrised by the title of radial motion. When a sunspot lies asymmetrically with respect to the spectroscope slit, even though the slit lie in the direction of the node, if the slit is placed across the penumbra on the side of the spot nearest the centre of the disc the lines are invariably convex towards the violet, and on the limb side the displacement is always towards the red. From the change in position-angle of the direction of maximum shift, as the spot is presented to us in different aspects by its passage across the sun's disc, it would appear that these displacements must be due to motion of the spot material. The direction of greatest shift has always proved to be that passing through the centre of the disc, but as the observations cannot be made with certainty beyond about 10°, it is possible that there may be a slight relative slow rotation of the penumbral gases in addition to the radial motion, but up to the present no evidence of any such spiral motion has been detected. Recent work appears to show that this radial movement of sunspot gases is almost confined to the reversing layer, as in the higher chromosphere the characteristic lines are generally twisted in the

MAP No. 9.



MAP No. 9

Libra, Sagittarius, Scorpio.

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opposite direction to the other lines, indicating an inward movement, probably of similar nature to the observation of Hale, where a dark flocculus was drawn in towards the centre of a spot. However, if a vortex does exist, it apparently does not affect the absorbing gases of the reversing layer of the spot penumbra. An interesting fact brought to notice by this work is that the phenomenon has evidently been frequently observed before, but no attempt made to elucidate the causes which produce it. The earliest observation appears to be by Vogel on May 6, 1871, when the appearance is well shown in a diagram, the special case being the double twisting often seen on the lines between two sunspots.

BOTANY.

By G. MASSEE.

WILD FLOWERS AROUND ALEXANDRIA.—Rear-Admiral Sir R. Massie Blomfield, K.C.M.G., has given a most interesting account, in *Bull. Alexandria Hort. Soc.*, of the flora in the district likely to be covered in the ordinary excursions of residents in the city and its suburbs. The area includes about fifty miles on either side of Ras-el-Tin, and a line parallel to the coast at a distance from it of twenty-five miles. It includes a large enough area of both desert and irrigated ground to illustrate the widely differing character of the flora indigenous to these portions of the district, which includes about 740 species, or more than one-half of the entire Phanerogamic Flora between the Turkish border east of the Suez Canal and the First Cataract of the Nile at Asuân.

Although interesting plants may be found in the region outlined, either in flower or fruit throughout the year, the flowering season *par excellence* begins about the end of December after the autumn and winter rains; the precocity and abundance of desert flowers naturally depends on whether the rains have begun early (beginning of November) and on the amount which has fallen, the average rainfall being a little under nine inches.

There are not many species in flower in January, but amongst the earliest is the desert saffron (*Colchicum ritchii*), very abundant, with clusters of pink crocus-like flowers. The corms are sold in the bazaars under the name of "aookna" for medicinal purposes.

The polyanthus daffodil (*Narcissus tazetta*), having white flowers with a yellow cup, is fairly plentiful on the Lake side of the Khedivial railway. At the end of January the fragrant dwarf stock (*Matthiola acaulis*) begins to cover the waysides E. and W. of the city, scenting the sunset air. By the first week in March the desert between Ras-el-Tin and Cape Brûlos is becoming gay with annuals. A feature is the great number of leguminous plants, amongst which is conspicuous the handsome yellow milk-vetch (*Astragalus alexandrinus*) and the shrubby yellow rest harrow (*Ononis vaginalis*). No less than eleven kinds of clover may be met with, of which the commonest one is rose-coloured with clustered bladdery fruit (*Trifolium tomentosum*). One of the most showy desert plants, occasionally found by the seashore, parasitic on roots of the goosefoot family, is the "golden broom rape" (*Phelipæa lutea*). Among the later flowers of the eastern area are the two celebrated lotus waterlilies, the petals of which are found in Royal Pharaonic coffins; *Nymphæa lotus* has white oval petals and edible roots; *N. caerulea* has blue pointed petals and a gold centre. Both are to be found in canals near Rosetta and Kafr Dewâr. The only Egyptian fern is the common maidenhair (*Adiantum capillus-veneris*), which may be looked for in every well, and on the banks of the Mahmoudieh Canal. In the western area Jerusalem sage (*Phlomis fruticosa*) is quite a feature. An "arum" (*Helicophyllum crassipes*) with a deep purple spathe and large pedate roots is frequent at Mex and Mariut; the roots are eaten like potatoes by the Bedouins.

NEW AND RARE SCOTCH MOSSES.—The veteran cryptogamist, Dr. James Stirton, has given an interesting and valuable account of some new and rare mosses from the West of Scotland, in the *Ann. Scot. Nat. Hist.*

The new species, of which full descriptions are given, are as follows: *Dicranoweissia sutherlandi* and *Mollia intumescens*, *Mollia inclinata*, *Hedw.*, was found, in fine fruit near Onich, the first fertile specimen found in this country. It is considered that *Mollia aggregata*, *Stru.*, is in all liklihood merely a curious form of *M. fragilis*, as specimens of the latter moss from Ben Lawers, where it is plentiful, shows at times the features on which *M. aggregata* has been separated as a species, namely, the entire smooth margin formed by the extension upwards of a single marginal row of hyaline cells, from the basal areolation. This is another illustration of the curious relationships of mosses of the west coast of Scotland to those on the eastern shores of Labrador, where *M. fragilis* was first found by Drummond.

After long experience in the study of mosses, the author strongly suspects that there is an alternation of generations between propagula, or vegetative reproductive bodies borne at the tips of the leaves, and spores. The production of spores implies a greater cost of energy, and that accordingly it becomes necessary at intervals for such an alternation to occur, in order to restore the balance of energy. Differences in the common areolation of the leaf, as observed by the author, are considered to serve the purpose, amongst other things, of diverting energy in new directions, so as to produce, by means of propagula, variations in type, and ultimately serve the purpose of producing new varieties, as well as new types, a proportion of which become permanent. This idea is supported by observations on *Ulota phyllantha*, which has hitherto been almost entirely progagated by propagula, but is now beginning to produce capsules in greater proportion as time goes on, while propagula, although still produced, rarely mature, but fall at an early stage of development, and at times are scarcely obvious at the tips of the leaves.

CHLOROPHYLL GRAINS.—Dr. J. d'Arbaumont has contributed some new observations on chlorphyll bodies, in *Ann. Sci. Nat.* The main conclusion arrived at is, that throughout the Phanerogams chlorophyll bodies are divisible into two main categories. Section A consists of monotypic corpuscles, always localised in special cells. Section B includes four subordinate varieties, each one of which may be localised in special cells, or they may be associated in different proportions in the same cell; such cells may be situated in the assimilating tissues of the stem or the leaves. The chlorophyll bodies of section A are morphologically superior to those of Section B, but are subordinate from the point of view of reducing the amount of carbonic gas present in the atmosphere.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

SEAWEEDS IN TIDAL WATERS.—A paper read by Dr. E. A. Letts at the recent International Congress of Applied Chemistry illustrates in striking fashion the way in which chemistry will often show the way to the solution of practical problems of civilisation. Prior to the sewage of Belfast being discharged, in 1889, into the lower part of Belfast Lough, green seaweeds of the *Ulva* and *Enteromorpha* species were practically unknown there. With the introduction of new drainage system, however, the improvement in the condition of the river was accompanied by the rapid growth of these seaweeds in the Lough, and the nuisance soon assumed unmanageable proportions. Thousands of tons were cast on shore, and notwithstanding the aid of special grants from the Irish Local Government Board for their removal, the public authorities were quite unable to cope with the evil. Last year, for instance, some 20,000 tons of seaweed were carted away during the first nine months, but the available funds being then exhausted

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nothing further could be done, and the thousands of tons subsequently cast up were left to decompose on the shore.

The experiments made by Dr. Letts show that *Ulva latissima* rapidly undergoes fermentation in warm sea water, apparently through the action of a specific micro-organism. In the second stage of fermentation another micro-organism, probably, *Microspira estuarii*, reduces the sulphates present, and liberates sulphuretted hydrogen. The seaweed contains a high proportion of nitrogen, which varies, however, with the purity of the water whence it was derived. Thus *Ulva* from the river Larne, which is only slightly polluted, contained 3.01 per cent. of nitrogen, whereas a specimen taken from Belfast Lough contained 6.18 per cent. Wherever seaweeds of these species occur in quantity, as, for example, at Falmouth, Southampton, and Teignmouth, they indicate pollution of the sea water by sewage. Nitrogen is very rapidly absorbed by *Ulva latissima* from sea water, especially when it is present in the form of ammonium salts, but the growth is also stimulated by the presence of nitrates. Hence the attempts to prevent the seaweed nuisance were directed towards the modification of the sewage in such a way as to remove the ammonium salts and reduce the proportion of nitrates, for it was found that albuminoid substances in a sewage effluent could not be absorbed by the *Ulva*, and that the amount of ammonia slowly liberated from them by decomposition was so small as to be negligible.

Experiments on a large scale showed that it was only possible to obtain a sewage effluent free from ammonia at the expense of the formation of a considerable amount of nitrate. On the other hand, when nitrates were mixed with the sewage in the septic tank they were rapidly decomposed with the liberation of carbon dioxide and oxides of nitrogen. The two processes were therefore combined in order to obtain a sewage effluent approximating the desired chemical condition. The solid matter was first removed by means of sedimentation tanks and catch pits, and part of the effluent oxidised by being passed through percolating filters. The highly nitrated filtrate was then mixed with the unfiltered effluent coming from the septic tanks and the mixture exposed to bacterial action on a contact bed. In this way a double effect was attained, the nitrates in the filtered portion being destroyed, while at the same time playing a part in the purification of the other portion of the effluent. The process, having proved satisfactory in the experimental stage, has been recommended to the Belfast Corporation for the treatment of all the sewage effluent of the town, and it is estimated that by this means the factors that lead to the formation of the seaweeds will be reduced to the extent of 80 per cent.

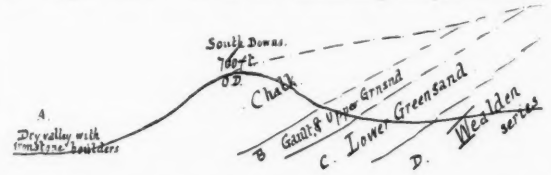
MONEL METAL.—An alloy consisting of 70 per cent. of nickel and 30 per cent. of copper is now being extensively used in the United States under the name of *monel metal*. It is smelted directly from the nickel-copper matte from the ores of the Sudbury district in Canada, and as the process only involves the separation of impurities and the reduction of the small amount of iron present, the alloy can be sold at a price only 2 cents per pound above that of copper. The advantages of monel metal are its great strength, exceeding that of nickel steel, and its great hardness, though this renders it more difficult to roll into sheets. Like nickel, it will take a fine polish, and it offers great resistance to atmospheric corrosion. It has recently been used for roofing a new railway station in New York, the sheets being fixed with nails made of the same material.

THE ACTIVE PRINCIPLE OF INSECT POWDERS.—Insect powders usually contain pyretol, a principle derived from *pyrethrum* flowers. A purified specimen of this compound, prepared by Mr. S. Sato, was a light yellow transparent resinous syrup, which produced a numbness when applied to the tongue. It was insoluble in water, but dissolved readily in ether and alcohol, to give solutions, which were neutral at first, but became acid on standing. It contained no nitrogen, and was therefore not of an alkaloidal nature. It proved very poisonous to cold-blooded animals, but had no apparent physiological action upon warm-blooded animals.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

A DRY CHALK VALLEY.—There is a long winding dry valley in the chalk of the South Downs which commences on the south-west of Ditchling Beacon, but a stone's throw from the northern escarpment, which, after meandering through Home Bottom, Denchea Bottom, Lower Standean, Donkey Bottom, and Ewe Bottom, joins the Brighton Valley at Patcham, and disappears at sea-level, where the Brighton Cliff Formation fills up the ancient estuary. Near Standean, the rubble which fills the bottom has recently been excavated along some considerable distance, and the contents of the drift have been exposed to view in heaps of flint and other stones by the wayside. It is noticeable that angular masses of flint are few in number, nearly all being sub-angular, and showing signs of transportation. These may not have travelled a great distance. There are other masses of flint which are completely rounded. These could not possibly have reached their rounded condition in being transported along the short distance from the escarpment to their present position, but must have commenced their sea-ward journey when the Weald still bore upon its shoulders the connecting bridge of chalk and tertiaries between the North and South Downs. But besides the flints there are rounded masses of dark red ironstone and rounded slabs of grey sandstone, these forming together about one per cent. of the larger flints. It is an interesting subject for consideration as to the origin of the sandstone boulders. It may be said that they resemble closely similar boulders found in the Brighton Raised Beach. It is possible that the ironstone may have been derived from the Lower Greensand or from members of the Wealden series, but it is not easy to say, from which of these two. There seems to be no other possible source of origin. But whether they came from the Lower Greensand or from the Wealden, their present position shows that when they became detatched from their original site they travelled over a ridge—the northern escarpment of the South Downs—which is now between 400 ft. and 500 ft. above the nearest approach of either formation, and this can only have been brought about at a time when the great Wealden denudation was but partially accomplished, and when southward-flowing rivers with considerable carrying powers were flowing over the Ditchling Downs from higher ground in the Weald. This will perhaps be made clearer by a diagram. Thus, the boulders at A must have come from C or D, when these formations were exposed to denudation, at a much greater height than now. It is not easy to explain why the dry valley in question, which is, of course, only a typical one, commencing as it does within a stone's throw of the escarpment, does not pierce the escarpment. The drop is somewhat sudden at its commencement. It is possible that underground solution may have carried on the work here, which the river had carried on before it was cut off in the lowered Weald. And weathering would just as quickly cut back a comparatively steep slope at the head of the valley, as it does in forming the cwms of Wales, or the corries of the Highlands. In fact, there is every reason to think that the agency was the same in all three cases. With regard to the grey sandstone slabs found in the Standean Valley, these so much resemble those isolated stones which are found on the Downs in various places, known as Sarsin Stones, that there seems no reason to doubt that they have been let down from formerly existing tertiary beds above the chalk.



Such beds may, however, have covered the chalk over the now denuded Wealden inlair. There is one large mass of this same material now resting at a height of about 625 ft. over the same valley, measuring 5 ft. by 3 ft. 3 ins., in its longest dimensions. It is semi-crystalline, and is of a pinkish hue in some parts. It appears to have been used in 1873-4 as beach-stone by the Ordnance surveyors. Such masses are, no doubt, the hardest portions of the lost tertiaries, and they alone have stood the disintegrating agencies of time.

GEOLOGY AROUND PLYNLIMON AND PONT ERWYD.—In a recent paper read before the Geological Society, Mr. Owen Thomas Jones, M.A., D.Sc., dealt with the Hartfell-Valentian Succession around Plynlimon and Pont Erwyd (North Cardiganshire), comprising an area of about 40 square miles lying in the hilly district about 12 to 16 miles east of Aberystwyth. Mr. Jones divides the rocks within the district into three Stages, which are further subdivided into Groups and Zones, as follows:—

VALENTIAN.	C. YSTWYTH STAGE.	(*c*) Rhuddnant Group.	2. Rhuddnant grits. 1. Rhuddnant shales.
		(*b*) Myherin Group.	2. Blaen Myherin mudstones. 1. Dolwen mudstones.
		(*a*) Devil's Bridge Group.	Mudstones with thin grit-bands.
	B. PONT ERWYD STAGE.	(*c*) Castell Group.	3. Flags and shales. (Zone of *Monograptus sedgwicki*.) 2. Shales and mudstones. (Zone of *Cephalograptus cometa*.) 1. Mudstones and shales. (Zone of *Monograptus convolutus*.)
		(*b*) Rheidol Group.	4. Black shales and mudstones. (Zone of *Monograptus communis*.) — δ. *Leptotheca*-band; γ. *Magnus*-band; β. *Triangulatus*-band; α. *Triangulatus*-var. band. 3. Flags and black shales. (Zone of *Monograptus cyphus*, s. s.) 2. Flags with thin shales. (Zone of *Monograptus rheidolensis*, sp. nov.) 1. Flags and shales. (Zone of *Monograptus atavus*, sp. nov.)
		(*a*) Eisteddfa Group.	2. Flags, shales, and grits. (Zone of *Cephalograptus ? acuminatus*.) 1. Flags with thin shales. (Zone of *Glyptograptus persculptus*.)
HARTFELL.	A. PLYNLIMON STAGE.	(*c*) Brynglâs Group.	Mudstones.
		(*b*) Drosgol Group.	Grits, conglomerates, and mudstones.
		(*a*) Nant-y-moch Group.	Flags with thin Shales. (Zone of *Dicellograptus anceps*.)

The Plynlimon Stage is developed in the northern part of the district, between Plynlimon and Pont Erwyd; the Pont Erwyd Stage along the two valleys of the Rheidol and the Castell, which converge near Pont Erwyd village; while the Ystwyth Stage is developed on the plateau-like tract extending from the Castell Valley to the Ystwyth Valley. The structure shows many points of interest and is clearly brought out by the mapping. Three types are dealt with—(1) folding; (2) strike-faulting; and (3) normal faulting; but the first is predominant. The rocks are folded into a primary anticlinal fold or anticlinorium, with a southerly "pitch" of 10° to 15°. This primary fold is composed of a number of secondary folds of a symmetrical type, with axes ranging nearly north and south and pitching as above. Occasionally the secondary folds are complicated by smaller folds or crumplings. The effect of the folding-structure on the rock outcrops, and especially on the topographical features, is dealt with in some detail. The latter are shown to be dependent in an important degree upon the pitch, and to a much smaller degree upon the dip of the rocks. Strike-faults play a minor rôle in the structure, and their effects are of little importance; they have not been observed to carry mineral deposits. The normal faults of the district are of more interest. They range in an east-north-easterly direction, and nearly always carry sulphidic ores of lead, zinc, or copper. They appear to be quite independent of the folding, and behave generally as if they were of later date. The paper contained a tabular list of fossils, correlation tables, and a description of two species of graptolites of zonal importance.

A NEW SPECIES OF LEPIDOPHLOIOS.—At the final meeting of the Geological Society's session, a paper was read on the Anatomy of *Lepidophloios laricinus*, Sternb., by D. M. S. Watson, B.Sc. The specimen described was found in one of the coal-balls of Lancashire, and shows the internal structure. The species is new, and is of the ordinary lepidodendroid type, but is remarkable for the great size and strength of the corona and the leaf-traces. *Lepidophloios acadianus*, Dawson, which is identical with *L. laricinus*, appears to differ in its internal structure, in having still stronger protexylen-points and leaf-traces. *Lomatophloios crassicaule*, Corda, which is *L. acerosus*, L. and H., appears to resemble greatly the Lancashire specimen of *L. laricinus* in its structure, and is quite distinct from the specimen of the same form described by Cash and Lomax. *Lepidodendron fuliginosum*, Will., a structural species, appears to include a specimen the external structure of which corresponds with *Lepidophloios acerosus*, *Lepidodendron obovatum*, *L. aculeatum*, and *Sigillaria discophora*. Under these circumstances, it is proposed to take no account of the impression-species in considering the synonymy of the structural specimens, and *vice versâ*. When the exterior of a structural specimen is actually known, it may be referred to by the name of the structural species, with that of the impression-species added in brackets.

THE GEOLOGISTS' ASSOCIATION LONG EXCURSION.—The long excursion of the Geologists' Association, from July 28 to August 7, will take its members to the Arenigs, under the direction of Mr. W. G. Fearnsides and the secretaryship of Mr. E. Montog. Headquarters will be at Bala. An eight-page leaflet, descriptive of each day's excursion, has been issued by the Association, and a capital opportunity is afforded the geologist of making a valuable acquaintance with the rocks of this fascinating neighbourhood. The various day-excursions do not exceed 12 miles walking distance in any case, whilst some are no more than 5 or 6 miles. A successful gathering is anticipated.

BRECIATION IN THE MAGNESIAN LIMESTONE.—Memoir No. 1 of the University of Durham Philosophical Society consists of a paper by D. Woolacott, D.Sc., F.G.S., on a case of thrust and crush breciation in the magnesian limestone of County Durham. It is illustrated by 20 good photographs of coast exposures, with plans and figures in the text. The paper is one which shows a great amount of labour in the working out of the subject, and the University is to be congratulated on the excellence of its first memoir.

CRETACEOUS PLANTS FROM JAPAN.—Miss Marie Stopes, D.Sc., has been investigating the microscopic structure of certain fossil Japanese plants. The fossils are of cretaceous age, and are found in nodules in the river beds of the mountainous region of northern Japan. They include ferns, gymnosperms, and angiosperms, some being species new to science. It is stated that several specimens show the structure of the floral parts of the plant.

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METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

METEOROLOGY IN THE RECENT ANTARCTIC EXPEDITION.—Everyone has been pleased to hear of the safe return of Mr. E. H. Shackleton and his companions from their famous expedition to the Antarctic. We understand that Lieutenant J. B. Adams, who was the meteorologist of the expedition, will give an account of the meteorological work and some of the results obtained at an early meeting of the Royal Meteorological Society. Mr. Shackleton and other members of the expedition are expected to be present on the occasion.

THE WEATHER OF JUNE.—The mean temperature of June was below the average over the whole of the British Isles. In the London district the month was one of the coldest Junes on record. Dr. H. R. Mill reports that at Camden Square, where the records extend back to 1858, the mean temperature for June, 1909, was 55°.6, which was 4°.8 below the average, and nearly a degree lower than that of the previous coldest June, and that the mean maximum temperature was only 63°.9, or 7°.4 less than the average.

With regard to rainfall, Dr. Mill shows that the rainfall of England and Wales was, as a whole, 141 per cent. of the average; that of Scotland, on the other hand, was only 69 per cent. of the average, the month having been a dry one, and the rainfall of Ireland comes out as 83 per cent. of the average.

METEOROLOGICAL CHARTS OF THE ATLANTIC AND PACIFIC OCEANS.—The U.S. Weather Bureau has commenced with July, 1909, to publish meteorological charts of the North Atlantic and North Pacific Oceans monthly, and of the South Atlantic Ocean quarterly. It is proposed also to issue a seasonal chart of the South Pacific Ocean quarterly, from September next. The Weather Bureau receives reports from 2,100 observers on vessels of every nationality, and from these reports prepares daily synoptic charts of the meteorological data, being thus enabled to plot the meteorological conditions prevailing over the oceans from day to day, for the purpose of tracing storm-tracks, percentage of fog, prevailing direction of wind, trade-wind limits, pressure and temperature.

LICHTNING PHENOMENA.—Mr. ———— gave in a recent number of the *Electrical Review* an interesting experience which he had a few weeks before of lightning phenomena. He says: "On May 25 last we had a very violent thunderstorm between 10 and 11 p.m.; before it subsided the exchange rang me up on the telephone, informing me that my line was badly earthed and that he would have to cut me off. It rained heavily and a ceiling of a bay window began to leak; the drops of water forming through the leaks in the plaster assumed a pear-shape and jumped a distance of 9 inches through the air almost horizontally to the curtain rings at the top of the window. The rings (metallic) were almost in contact with the lightning arrester of the telephone. I short-circuited the point of formation of the drops and the rings, when the former fell plumb, but immediately after removing the short circuit they again jumped as before. I concluded that the ceiling had become electrically charged by the surrounding atmosphere, the lead of the roof acting as a condenser, then silently discharging from the ceiling through the rings to the lightning arresters and thence to earth.

"So much interested was I that I communicated with Sir Oliver Lodge, and further suggested to him that the above might explain the unaccountable ringing of ordinary (not electric) house bells such as has occurred in the writer's and also in a friend's house. In his reply he is of the same opinion."

KEW OBSERVATORY, RICHMOND, SURREY.—In the Report of the National Physical Laboratory, 1908, some account is given of the work carried on during the past year at the Observatory Department, Richmond, Surrey. This is more generally known as the "Kew Observatory." The magnetic, meteorological, and seismological observations have been regularly carried on as usual. The mean magnetic results were:—

Westerly Declination	16° 16′.9 W.
Horizontal Force	0.18515 C.G.S. unit
Inclination	67° 0′.9 N.
Vertical Force	0.43651 C.G.S. unit

The principal meteorological results were:—

Temperature.—Mean 50°.0; Maximum 81°.2 on July 3; Minimum 14°.7 on December 30.

Rainfall.—Total 22.265 ins.; Maximum 1.600 ins. on January 7.

Bright Sunshine.—Total 1544 hours.

An important branch of the work of the Observatory is the verification of instruments. During 1908 the total number of instruments—exclusive of watches and chronometers—tested was 30,391. Among these were: Aneroids, 86; Barometers, 225; Binoculars, 1,238; Hydrometers, 613; Sextants, 1,154; Telescopes, 3,177; Thermometers (clinical), 18,752; Meteorological, 4,719; others, 244; Miscellaneous, 183. The number of instruments rejected on account of excessive error or for other reasons was 834.

ORNITHOLOGY.

By W. P. PYCRAFT, F.L.S., F.Z.S., M.B.O.U., &c.

TAMPERING WITH OUR NATIVE BIRDS.—The introduction of non-indigenous species of birds into Great Britain, whether for purposes of sport, or motives of sentiment, is greatly to be deplored, and it is a pity that those who engage in this mischievous practice cannot be brought to see the error of their ways. Their action is entirely selfish and without excuse.

A case in point is furnished by the recent attempt to introduce the Willow Grouse into Scotland, where it will probably interbreed with the Red Grouse, thereby vitiating all further scientific observation on this peculiar species for ever, for the Red Grouse, it may be remembered, is absolutely peculiar to Great Britain, though doubtless closely allied to the Willow Grouse.

The same argument does not, however, apply to the introduction of birds which have an undoubted claim to be regarded as British, or which at some time bred regularly, or even sporadically, in these Islands. We should hail with acclamation, for instance, any attempt to re-introduce Kites for the sake of adding fresh blood to our fast declining stock; and we should regard with no less favour those who would introduce the Hoopoe and Golden Oriole. During recent years many importations of the Little Owl have been made, a bird which has a legitimate claim to be regarded as British.

This work was begun by the late Lord Lilford, and has been aided and abetted by the Hon. W. Rothschild and Mr. E. G. B. Meade Waldo, who turned down birds into Kent and Hertfordshire. These seem to have thriven amazingly, so much so as to cause some to doubt the wisdom of this work. The Hon. E. S. Montagu, at a recent meeting of the British Ornithologists' Union, affirmed, for instance, that in Cambridgeshire—into which county these birds have now spread—the Little Owls have wrought great havoc among the small birds, especially Goldfinches and Chaffinches; while gamekeepers contend that they take young Pheasants from the coops! Mr. Rothschild and Mr. Meade Waldo, however, while adding their testimony as to the increase of these charming little birds, assured the members that the harm done is more imaginary than real, and their testimony should carry great weight.

CROSSBILLS IN HAMPSHIRE.—The *Field* for July 10 contains a record of the fact that about a dozen Common Crossbills were seen at Baddesley, near Romsey, Hants, during the first week in July.

LITTLE BITTERN IN ORKNEY.—Mr. W. Cowan, in *British Birds* for July, records the fact that an adult male Little Bittern (*Ardetta minuta*) was caught alive at the Stennis Loch, Orkney, on May 14. Only one other specimen seems

to have been taken in Orkney, and that was from Sanday in 1806.

LARGE CLUTCHES OF EGGS OF THE CREAT CRESTED GREBE.—Miss E. L. Turner and Mr. L. W. Crouch, in *British Birds* for July, each record the finding of nests of the Great Crested Grebe containing six eggs. Mr. Crouch has, during three successive years (including 1909), found a nest so plenished, in nearly the same place, on Weston Turville Reservoir, Herts, apparently, therefore, of the same pair of birds.

The nest found by Miss Turner was on one of the Norfolk Broads—happily on private water.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

A NEW SODIUM FLAME.—There are many devices for securing a bright sodium flame for ordinary laboratory use. The following new device introduced by the Rev. B. J. Whiteside, S.J., of Stonyhurst, is delightfully simple and effective, and ought to come into general use.

The gas on its way to the burner is led into a test tube containing dry salt powdered very finely. The nozzle by which the gas enters passes through a cork which permits it to be adjusted so as to be just above the salt. A lateral tube permits the exit of the gas to the burner. When the gas is turned on the jet disturbs the salt dust, which is then carried forward to the flame. The result is a very steady and solid sodium flame. The rate of supply of salt can be adjusted by raising or lowering the nozzle. Sodium fluoride or calcined borax may replace the chloride; or, presumably, also the mixture of borax and salt which Lord Rayleigh found so efficient when used in the ordinary way. Lithium carbonate, if dried, gives a convenient lithium flame for spectrum work.

The efficiency of this device depends upon the fact that *fresh* salt is being continually fed into the flame. It is a matter of common knowledge that when salt is first placed in a flame the yellow light is very much brighter than after a short interval. It is usually taken for granted that the initial effect depends upon the presence of an impurity, which, perhaps, assists dissociation. Lenard has shown that the various lines in a salt spectrum are due to electrically-charged particles, some moving one way in a magnetic field and others in the reverse. This implies, in all probability, a breaking up of the molecules before it can give out its characteristic rays, and whatever the ultimate explanation may be, the salt is initially much more easily put into this state than it is after being a short time in the flame.

Apprehension might be felt that the burner will soon be choked by the accumulation of salt within it. In practice, however, most of the salt is blown out of the bunsen by the jet of gas. The device thus, even in this particular, compares favourably with the usual wire support, the feeding of which always involves a plentiful (though unintentional) re-feeding of the cylinder of the bunsen itself.

THE THEORY OF THE GREENHOUSE.—In the *Philosophical Magazine* for July C. G. Abbot, the Director of the Astrophysical Observatory of the Smithsonian Institution, endeavours to calculate from known data with respect to radiation and convection the relative efficiency of glass and rock salt as the cover to a "hot-box" or greenhouse. This is done in reference to Professor Wood's experimental disproof of the currently accepted theory of the action of a greenhouse already referred to in these columns.

He concludes that of the heat which would have escaped from a coverless box at 55° C. in still, moist air at 15° C. a rock salt cover hinders 65 per cent. as much as glass. Remembering, however, that, owing to its higher absorbing power for long wave-lengths, the glass will be warmed more than the salt, the convection loss from the outside of the warmed cover will be greater for glass than for salt, so that the efficiency of a salt cover may be much more than 65 per cent. of that of one of glass. The convection loss from the front of the cover is a considerable factor. When this is prevented by an additional cover the inner one becomes too hot to touch. In an experiment with a box with three glass covers the inside temperature rose to 118° C. in the sun, whereas Wood's maximum was 55° C.

Although the efficiencies of rock salt and glass turn out ultimately to be not much different (in agreement with Professor Wood's conclusion), yet Mr. Abbot's conclusion is that this is largely due to difference in convection from the outside surface of the cover, and that the "trapping" of long-wave radiation (emphasized in the generally accepted theory) may be more important than Professor Wood thinks.

ZOOLOGY.

By R. LYDEKKER.

THE SLIPPER LIMPET.—It might well have been imagined that we knew almost all that there is to be known regarding the life-history of such a comparatively common British mollusc as the slipper-limpet (*Crepidula fornicata*), but specimens recently taken at the mouth of the river Crouch, a couple of which are exhibited in the British Museum, show a phase which appears to have been hitherto undetected. These limpets have depressed, oval shells, with a kind of pocket inside from which they take their name; and when young move about after the fashion common to limpets generally. Later on, however, they collect into chains, one overlying the other, and comprising from two to a dozen individuals, of which the lowermost is attached to a shell or some other object. The most curious feature about these chains, according to a paper communicated recently by Mr. J. H. Orton to the Royal Society, is, however, the circumstance that the individuals near the attached end are females, and those at the opposite extremity are males, while those occupying the middle portion are intermediate as regards sexual characters between females and hermaphrodites on the one hand, and between males and hermaphrodites on the other. Hence it seems to be demonstrated that while these molluscs commence their lives as males, they end by becoming females.

A NEW PARASITIC CRUSTACEAN.—The above-mentioned phenomenon—that is to say, males becoming females with advancing age—is, however, by no means peculiar to the slipper-limpet. It occurs, for instance, among the members of those degraded isopod crustaceans, known as epicarids, which in the adult condition are parasitic upon other members of their own class. Among these is the genus *Dajus*, belonging to a group of four families, the representatives of which usually infest decapod crustaceans. This genus has been long known to science, but an allied type, for which the name *Prodajus* is proposed, has recently been discovered off Ostend, infesting the nursing-chamber of the females of a common species belonging to the rhizopod (or, as it is now called, eumalacostracan) group, and known as *Gastrosaccus spinifer*. As the host abounds off Ostend, while the parasite is so large as to completely fill the nursing-chamber in which it takes up its quarters, it is remarkable that its discovery has been so long delayed.

THE LIVE TAKIN.—The attraction of the month at the Zoological Gardens has been the young Bhutan takin, the first living representative of its kind ever brought to Europe.

CORRESPONDENCE.

Another View of Nightingale Land.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In the June issue (1909) of "KNOWLEDGE," Mr. G. W. Bulman, M.A., B.Sc., advanced the theory that the distribution of the nightingale may be explained geologically: "The nature of the strata determines the prevailing vegetation, and this in turn affects the insect life; in other words, the nightingale's food supply."

Mr. Bulman quotes Professor Newton, that Copenhagen is the extreme northern point reached by the nightingale. From twenty years' residence in Northern Russia and

Finland, I can assure your readers that the nightingale can be heard anywhere along the south shore of the Gulf of Finland, and is very plentiful in the parks and districts surrounding St. Petersburg, which lies on the 60° parallel or the latitude of the Shetland Isles. I believe that during the Russian summer the nightingale migrates much farther north, and if etymological evidence is of value, the site of the famous monastery on the island in the White Sea, known as Solovetsk (bombarded by a British squadron in 1855), means "the place of the nightingale." This is north of 65° latitude.

Although plentiful in the district of St. Petersburg and along the south shore of the Gulf of Finland, it is very seldom heard in Finland. In the summer of 1895 a nightingale nested in our garden on the north coast of the Gulf of Finland, some 20 miles to the west of Cronstadt; it returned in 1896, but since then has not been heard.

A reference to the map gives us, I think, the true explanation of the migratory distribution of the nightingale.

That the little bird has no objection to the older crusts of the earth is evidenced by the fact that the south coast of the Gulf of Finland is composed of the old Silurian deposit which rises to the surface throughout this district. The soil is generally very shallow and full of broken stone from the underlying rock; it may be remembered that Sir Roderick Murchison found these deposits of such value in identifying the sequence of strata.

The influence of the Gulf of Finland on the flight northwards of the nightingale may be instructively compared with the shape and similar effect produced by the intervention of the English Channel.

It has been remarked that the migration of birds to and from their summer quarters seldom appears to be due north or south, but rather takes a zig-zag course. The danger to small land birds of any wide expanse of water is apparent; for this reason the immediate neighbourhood of the Atlantic is avoided, and we find, as Mr. Bulman notes, that the nightingale is unknown in Brittany.

The English Channel and the Gulf of Finland, and, of course, the North Sea and Baltic, form natural barriers probably to other small migratory birds than the nightingale. The special notice this little songster always attracts to itself may be the means of explaining one of the many problems connected with the migration of birds.

Yours, etc.,

HUGH R. WATKIN.

The Heredity of Acquired Characters in Plants.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Your review of this book requires a few words in reply. The reviewer says that *because* I use the expression "as far as Plants are concerned," *therefore* "the arguments advanced are considered not applicable to the Animal Kingdom." This is a *non sequitur*. As a matter of fact, I *do* consider the heredity of acquired characters by direct adaptation is equally true of animals, but I am only concerned with Plants in my book. I leave the question to Zoologists to answer.

The writer says: "The argument derived from cultivated plants is not admissible." This is a sweeping indictment against Darwin, for the whole of his evidence for his theory of the Origin of Species resides in his two 8vo volumes on "Animals and Plants Under Domestication." Moreover, the heredity of acquired characters he considered a *sine qua non*.

Again, the reviewer says of "artificially imposed changes are fleeting." They *may* or *may not* be so. Just as adaptations are in the wild state (see the comparison I give between the two species of Ampelopsis). Many garden plants "come true" or are "fined" by seed, which is exported to all parts of the world, though the power of varying again under changed conditions of life is always possible.

GEORGE HENSLOW.

Perpetual Calendar From A.D. 1-A.D. 1999.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The following suggestions for a perpetual calendar may interest you:—

To the year add its fourth part, omitting fractions; also add the day of the month, the "value" of the month, and the "value" of the century.

Divide by 7, and the remainder shows the day of the week (treating remainder *0* as equivalent to 7).

The advantage of the rule is that it can be worked in one's head without any tables.

Note 1.—For January and February in a Leap Year reduce the remainder by 1.

Note 2.—The "value" of a month is given by the Sunday letter affixed to the first day of the month.

Thus, to June 1 is affixed E, the fifth letter of the alphabet; therefore the "value" of June is 5.

Note 3.—In Old Style the "value" of the century is always 4.

In New Style (which, in England, began on September 14, 1752) the "value" of the century is obtained by subtracting the first two figures of the date from 24.

This rule will apply equally well to countries in which New Style began on October 15, 1582, if 8 be used as the "value" wherever the rule would give 9.

Example—Sept. 15, 1793.

1793
448
15
0
7

7/2269

324 − 1, = Sunday.

Faithfully yours,

C. W. BOURNE.

REVIEWS OF BOOKS.

BOTANY.

Studies in Fossil Botany; Vol. II.: Spermatophyta, by D. H. Scott, M.A., F.R.S, (London: Adam and Charles Black; 5s. net).—A second edition of this well-known book will be welcomed by everyone interested in the broader aspects of the Vegetable Kingdom. It is called a second edition here, out of deference to the title page, but, in reality, it is practically a new book; some chapters are altogether new, and others have been so extended to incorporate important new discoveries, that but little of the original work remains unmodified. Among the new features incorporated may be mentioned the Pteridosperms, a new group of seed plants, including such Cycadofilices as prove to have borne seeds. This includes a considerable amount of patient work and investigation, beginning with Oliver and Scott on Lagenostoma Lomaxi, etc. Weiland's studies on the detailed structure of the flowers of certain Bennetteteæ, and discovery of their bisexual nature is also discussed, and along with other considerations enable the author to summarise the evolution of the Spermatophyta as follows:—"It thus appears, if the views here taken are justified, that the whole of the Spermatophyta, whether Angiospermous or Gymnospermous, were ultimately derived, through primitive seed-plants of the nature of Pteridosperms, from the same stock with the Ferns.

Elementary Practical Botany, by Wm. E. Clarke (The Normal Press, Ltd.; 3s. 6d. net).—Considering the size of the book, at least fifty times too much information is attempted; in fact, it runs, in a way, through the whole gamut of botanical knowledge. Terms are present galore. Such nonsense as "an upper stalk" for petiole or leaf-stalk, and a "lower base with a pair of small leaf-like attachments" for stipules, shows the style adopted. The spelling is sometimes original; on page 253 we learn that the three leaflets of a laburnum leaf are connected by short *pedicles*. One more quotation only is necessary. "When the first flower to open is at the growing point, no more can develop, and we have a definite inflorescence."

CHEMISTRY.

Practical Organic Chemistry, by J. I. Sudborough, D.Sc., F.I.C., and T. C. James, M.A., B.Sc. (London: Blackie and Son; pp. xvi. and 378; 5s. net).—This book is intended as a practical companion to Dr. Sudborough's edition of Bernthsen's "Organic Chemistry," and it fulfils its purpose so well as to be sure of a welcome from all who know the theoretical work. It not only describes the preparation of the various types of carbon compounds, but also deals at length with the physical methods more commonly used for their identification, and includes a useful scheme of organic qualitative analysis. So fully described are the various experiments, and so well is the necessary apparatus illustrated by means of photographs and diagrams, that the book may be recommended as an admirable guide to the student, who is working at organic chemistry without the assistance of a living teacher.

On the Calculation of Thermo-Chemical Constants, by H. S. Redgrove, B.Sc. (London: Arnold; pp. viii. and 102; 6s. net).—This book consists, in the main, of a reprint of papers that have appeared in the *Chemical News*, though it also contains a considerable amount of new material. It opens with a criticism of the method usually employed for the calculation of "additive" physico-chemical constants, and suggests in its place a method which the author claims to be more logical. In the rest of the book this new method is applied in the calculation of the thermal values of different classes of organic compounds, and the work concludes with an appendix criticising Thomsen's method of calculation. Numerous tables of the results increase the usefulness of the book, in which the worker in physical chemistry will find much to interest him.

Chemistry, by W. A. Tilden, D.Sc., F.R.S. (London: Dent's Scientific Primers; pp. ix. and 108; 1s. net).—Professor Tilden is well known as a writer who can make the subject of chemistry interesting to a non-scientific reader, and in this little book he gives a further proof of this gift. The various processes of chemical combination and decomposition are clearly described, and each stage is illustrated by simple experiments so chosen as to form logical steps to what follows, so that the reader who has mastered the few pages of which the book consists will have obtained a grasp of the principles of chemistry. Our only criticism is that the subject is far too wide to be treated effectively in so short a space, and that the matter is apt to be disjointed, especially towards the end of the book. This fault, however, is inseparable from any attempt to compress chemistry into 108 small pages.

GEOLOGY.

A Treatise on Zoology, edited by Sir R. Lankester, K.C.B., Part IX., Vertebrata Craniata (First fascicle, Cyclostomes and Fishes), by E. S. Goodrich (London: A. and C. Black, 1909; pp. xvi. and 518, illustrated; price 12s. 6d. net).—While congratulating the editor at the rapid progress which is now being made with the issue of this monumental work, we venture to protest against the complicated system of numbering its component volumes. Surely it would have been much simpler and much more convenient to have called the various portions of the work volumes and to have numbered them in regular sequence. The same unnecessary complexity and prolixity characterise, in our opinion, the scheme of classification of fishes adopted by Mr. Goodrich in the "fascicle" now before us. It is not, indeed, that this classification differs so very widely from others previously published, but it is overloaded with unnecessary divisions. We have, for instance, such divisions as "subphylum," "branch," "grade," "class," "sub-grade," "sub-class," "order," "group," "division," "sub-division," "sub-order," "tribe," "group" (lower rank than before), "family," and "sub-family." The only word for such a scheme is that it is absurd, and any man who can draw up such a complex and puzzling classification must be altogether outside the ranks of ordinary, common-sense Englishmen. We notice that the author replaces the generally accepted name *Cestracion* by *Heterodontus*, although he retains the family term *Cestraciontidæ;* this is another absurdity. We are glad, on the other hand, to find the author accepting that the false sawfishes (*Prestiophorus* and *Pleotrema*) have nothing to do with the true sawfishes. As regards the anatomical portion of the work—and Mr. Goodrich is essentially an anatomist—we have nothing but praise to bestow, and it is especially satisfactory to have the author's views on fin-structure embodied in a text-book. The work is undoubtedly a most valuable contribution to ichthyological morphology.

PHYSICS.

An Elementary Text-Book of Physics, by Dr. R. W. Stewart (London: C. Griffin and Co.; Part II., Sound, 2s. 6d. net; Part III., Light, 3s. 6d. net).—These two small books are intended for school use. Dr. Stewart has great experience in the writing of text-books, and he has executed each of these with his usual ability. Each, however, presents merely the rudiments of the subject. A beginner may no doubt read these with advantage and thus prepare the way for the study of more adequate text-books.

MISCELLANEOUS.

The Industrial and Commercial Influence of the English Patent System, by A. F. Ravenshear, B.Sc. (London: T. Fisher Unwin, 1909; 5s. net).—This book is offered as a contribution towards making good the absence of any dealing with patents on the economic side. The writer has been led to his task partly by the recent amendments in our Patent Law and partly from the fact that a sufficient period has elapsed since the total abolition of patents in Holland (in 1869) to enable some of the consequences to become apparent. He considers that while improvement of the agricultural arts has proceeded to a great extent independently of patent protection, the manufacturing trades in Holland have been relatively less favourably circumstanced than those in neighbouring countries. Abuses of the patent monopoly are dealt with and the general conclusions are tested by reference to a number of patents which have established their claim to consideration by surviving their full term. The work concludes with a brief comparison of the economic features of the systems in vogue in different countries. The book is well and clearly written, and it need only be mentioned that Mr. Ravenshear is in a position to speak authoritatively on his subject.

Science Progress.—In the July number of *Science Progress* (Murray; 5s. net).—Dr. W. J. Sollas continues his series of articles on Palæolithic Races, Mr. Newell Arber sums up in a convenient and comprehensive fashion "Recent Progress in the Study of Carboniferous Plants," and Mr. Thirkell performs the same task in a rather less summary way for the latest work respecting ultra-microscopic particles. In "Recent Work on the Determination of Sex," Mr. Leonard Doncaster concludes that research is pointing to the overwhelming probability "that the determination of sex is not consequent on the accidental preponderance of one or other of two nicely-balanced tendencies, but is due to fixed and unalterable characters inherent in the germ cells." Mr. Herbert Parsons, in analysing the deleterious effect of bright light upon the eyes, makes out a serious case against some forms of ultra-violet illumination, Mr. Schwarz has a striking article on the "Organisms of the Soil," in which he states grounds for the belief that life originated in the soil and not in the sea, and Dr. Felix Oswald writes on "The Degeneration of Armour in Animals." A writer, whose identity is very unsuccessfully concealed by the initials "H. E. A.," writes with all the vigour that he usually puts into chemical controversies on the lack of proper encouragement of science at Oxford. In "Oxford on the Upper Grade" he points out with irresistible logic that an entirely false standard is set to the educational work of each and every public school by the standard and character of scholarship examinations at the Universities' colleges. "It is practically impossible for those who are proceeding to the Universities to obtain a satisfactory general education at school, a high degree of specialisation being necessary to secure success in the scholarship examinations." In Germany the Universities have no such scholarship system.

Colliery Surveying, by T. A. O'Donahue, F.G.S. (London: Macmillan and Co., 1909; 3s. 6d.).—This appears to be an excellent little book dealing in a practical way with its subject-matter. It is in reality a new edition; but with such extensive revisions and additions as to be practically a new book.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, M.A., F.R.M.S.

Royal Microscopical Society.

June 16.—Mr. E. J. Spitta, M.R.C.S., etc., Vice-President, in the chair. A very interesting old microscope by George Adams was exhibited and described, which had been recently purchased by the Society, and which was in remarkably fine condition, almost as good as new. Dr. J. A. Braxton Hicks exhibited a number of the better known Tropical Parasites which were the active causes of various diseases, arranged under sixteen microscopes. They were as follows:—(1) *Plasmodium malariæ*, showing "Daisy" forms or "rosette" stage of the Parasite of the Quartan Malaria just previous to the production of a rigor. (2) *Plasmodium vivax*, the Parasite of Benign Tertian Malaria, which had attained its full growth and was just ready to produce a rigor in the patient (showing "rosettes"). (3) This was a remarkable preparation (known as Sub-Tertian Malaria), showing the crescent form of Malignant Malaria and a double infection of Benign Tertian Malaria, obtained from the blood of the same patient. (4) *Amœba dysenteriæ*, the Parasite of Amœbic Dysentery. (5) The adult worm of *Bilharzia hæmatobia* (*Schistosomum hæmatobium*), showing the typical anterior and ventral suckers, and the gynæcophoric canal. (6) The Ova of *Bilharzia hæmatobia* imbedded in the rectal mucosa. (7) *Filaria diurna* (*Microfilaria loa*) in the diurnal blood of a patient, the subject of Calabar swellings, showing also the sheath and abrupt termination of the nuclear core. (8) *Filaria perstans*, showing the characteristic absence of sheath of this form of *Filaria*. (9) *Filaria medinensis*, Embryo from the uterus of the guinea worm. The adult female occupies the subcutaneous tissues of the leg, and having pierced the skin, discharges the embryos when the leg comes in contact with cold water. These embryos then enter a *Cyclops*, in which they undergo further development, and the water containing the *Cyclops* being drunk, infects the drinker. (10) *Filaria nocturna*, in a section of lung, showing the embryos in the pulmonary vessels, where they remain during the day, coming out into the peripheral circulation only at night; the adult worm causes lymphatic obstruction and hence elephantiasis. (11) *Filaria nocturna* (*Microfilaria bancrofti*), in the nocturnal blood of a patient with hydrocele; showing also the characteristic sheath and abrupt termination of the nuclear core. (12) *Trypanosoma gambiense*, from the blood of a rat inoculated with the blood of a case of sleeping sickness. (13) The *Leishman-Donovan* bodies found in the spleen and liver in cases of Kala-azar. Similar bodies are also found in the pus from Delhi boil, but any relationship between the two has yet to be proved. (14) *Spirochæte obermeieri*, Spirillum of Relapsing Fever. (15) *Bacillus lepræ* (Hensen's Bacillus), the Bacillus of Leprosy, taken from the nasal mucus of a case of Leprosy. (16) *Bacillus pestis*, section of lung from a case of Pneumonic Plague, showing the typical Bacillus in the tissues. Mr. J. W. Gordon reported that the Society gave an exhibition of Metallurgical Microscopes at the Reception of the Members of the International Congress of Applied Chemistry, on June 1, at the Natural History Museum at South Kensington, on which occasion they were the only Society exhibiting.

The Admission of Women to the Meetings of the Royal Microscopical Society.

At a special meeting of the Royal Microscopical Society, held on June 16 at the close of the ordinary meeting, the question of the admission of women Fellows to the full privileges of the Society was considered and voted upon. Hitherto the Society has not admitted women to its meetings, not even its few women Fellows, but it has recently been proposed that this restriction should be abolished. The proposal, unassailable on the ground of justice, met with no little opposition on the ground of expediency, it being pointed out that the present informal character of the meetings might be altered, that there might be restraint in discussion of many biological matters coming before the Society, and that the proposal would meet with much disapproval from many of the Fellows, whilst it was primarily put forward on merely abstract grounds, as part of the present agitation for the removal of all disabilities from women, and that there was no prospect of any material increase of members to the Society as a result of the alteration in the rules, whilst there would probably (one speaker said certainly) be several resignations from disaffected members in consequence. A special Committee had been appointed to deal with the matter, and they had taken a post-card ballot of the Fellows, with the result that out of 284 circulars, to which 205 replies had been received, 105 had expressed themselves in favour of admitting women to the meetings, 42 were against it, and 17 were indifferent. With regard to the proposal to admit women to seats on the Council, 108 were in favour and 74 against it; whilst in reply to a request for the names of any ladies who would actually join the Society if the Bye-laws were altered, not a single name was put forward. It will be seen that the meeting was somewhat in a quandary, abstract principles of justice demanding the alteration; whilst the fact remained that women generally showed no desire to join the Society (though it was mentioned later that six women Fellows of the Linnæan Society were prepared to join) or to make up for the possible defection of Fellows who objected to the alteration, and who looked upon the whole movement as part of an agitation which has notoriously recently suffered much in public estimation by the proceedings of extremists. The report of the Committee was, on the whole, adverse to the proposed change, in spite of the favourable result of the postal ballot, and one of the chief movers in the matter was so impressed by the strength of the opposition (whether justified or not) that he wrote counselling delay. A proposal was accordingly made to postpone the matter by referring it to the Council for consideration and decision, but the sense of abstract justice was in the ascendant at the meeting and triumphed over considerations of expediency, or material gain or loss, so that an amendment was ultimately adopted that the Bye-laws of the Society be altered accordingly, 22 Fellows voting in favour and 7 against; whilst for the amendment put as a substantive resolution, 20 voted in favour of it and 5 against. Though the meeting was regrettably small in numbers, it is to be earnestly hoped that the dissentient Fellows will not carry their disapproval to extremes, but will loyally accede to the wishes of the majority, and that the result may be an increased number of women Fellows, earnest and keen workers in biological science.

XUM

Journal of the Quekett Club.

The last half-yearly issue of the Quekett Club, published in April, contains the Proceedings of the Club during October, November, and December, the Annual Report, the Treasurer's Report, and six papers by members of the Club. Both reports show a satisfactory maintenance of the Club's usefulness and prosperity. The papers include an account of "The Structure of the Eye-Surface, and the Sexual Differences of the Eyes in Diptera," by Mr. W. Wesché, F.R.M.S., with illustrations; a paper on "The Locomotion of Microscopic Aquatic Organisms," by Mr. D. J. Scourfield; a description by Mr. T. B. Rosseter of a new species of tapeworm, *Hymenolepis acicula sinuata*; and of a new species of *Technitella*, one of the foraminifera, by Messrs. Heron-Allen and Earland, with beautiful photomicrographs taken by reflected light. The Proceedings contain an interesting account by Professor Minchin, President of the Club, of his methods of obtaining specimens of blood parasites. Observing that trypanosomes were found only in vertebrates and that every known species of vertebrate was the host of a trypanosome, and quoting in this connection the part probably played by them in sleeping sickness, though many were quite harmless, and after exhibiting specimens found in various freshwater fish such as bream, pike, tench, eels, etc., taken in the Norfolk Broads, Professor Minchin gave the following directions for preparation:—The easiest method of obtaining specimens is to take a common eel alive, and kill it by a blow on the head with a blunt instrument. Take a drop of blood from the heart as quickly as possible, as the blood of fish coagulates much more rapidly than is the case with mammals, and put under a cover-slip. The blood dries round the edges and so seals up the enclosed film. In the case of a Norfolk Broad eel, well infected, after 24 hours specimens prepared as just described were still active, at 48 hours slower, and at 72 hours nearly moribund. If, after putting on the cover-slip, the preparation is at once sealed with vaseline, these organisms have such extraordinary vitality that they will live and even divide. Professor Minchin had had some alive for nine days in this condition. An extensive range of size and structure had been noted in the eel, where all stages are found. In the pike, two sizes only, large and small, are common; in the perch three forms are found. *Trypanoplasma*, which, unlike *Trypanosoma*, contains two flagella instead of one, and is found only in fishes instead of in all classes of vertebrates, also shows dimorphism. It has been suggested that the large and small forms may possibly correspond to male and female, and the intermediate may be the form from which male and female may develop. Many problems are still unsolved concerning the life-history of these protozoa. The current idea as to the method of infection by fish was that they were carried by leeches.

Mounting of Algae.

The last issue of the Journal of the Royal Microscopical Society gives a useful summary of G. S. West's method of killing, fixing, mounting, and preserving algæ. The fluid used is a 2 per cent. solution of potassium acetate, made just blue with copper acetate. This medium reduces plasmolysis to a minimum. For permanent mounts thick slides should be used, and the cover-slip sealed down with gold size several times after each drying.

With *Vaucheria*, plasmolysis is hard to avoid, and the best procedure is to kill rapidly with 3 or 4 per cent. formalin, which must be completely washed out afterwards, or the preparations will turn black. The *Vaucheria* are then removed to 5 to 10 per cent. glycerin, to which a little thymol is added, and the fluid is then allowed to inspissate by evaporation by placing the vessel near a radiator. The author's procedure for mounting algæ is as follows:—After killing and fixing in the potassium-copper-acetate solution an equal bulk of 10 per cent. glycerin is added; the mixture is then allowed to concentrate by evaporation in a warm place, protected from dust. It is necessary to separate the algæ from all dirt, otherwise a precipitate of copper oxide occurs.

Notes and Queries.

Lectures on Microscopy at Jena.—Messrs. Carl Zeiss advise me that from the 11th to the 16th of October next a series of lectures, demonstrations, and practical lessons (the 4th) on scientific microscopy, will be given at the Institute for Microscopy of Jena University. The lectures will be in German, and applications for admission should be sent to Herr Dr. Ehlers, Jena, Beethovenstrasse, No. 14, early application being necessary. The subscription for the course of lectures, demonstrations, and practical lessons (together, 18 hours) is 20s., and for the lectures only (9 hours), 6s. I give the syllabus herewith, as it may tempt some of my readers who are keen on the subject (and who understand German) to attend the lectures, and to others it may show the ground covered by modern microscopy, and the contrast between the present neglect of the subject in our English Universities and Medical Schools.

Monday, Oct. 11.—Herr Prof. Dr. H. Ambronn (Jena),
3 to 4 p.m. Lecture on Abbe's Theory of the Formation of the Microscobic Image.
4 to 6 p.m. Practical Lessons with the Diffraction Apparatus, after Abbe.

Tuesday, Oct. 12.—Herr Prof. Dr. H. Ambronn, Lecture
3 to 4 p.m. on the Method of Testing Objective Systems.
4 to 6 p.m. Practical Lessons with the Abbe Test Plate and the Abbe Apertometer.

Wednesday, Oct. 13.—Herr Dr. H. Siedentopf (Jena), Lec-
3 to 4 p.m. ture on Dark-Ground Illumination.
4 to 6 p.m. Practical Lessons in Dark-Ground Illumination.

Thursday, Oct. 14.—Herr Dr. A. Köhler (Jena), Lecture
10 a.m. to 1 p.m. with Demonstration on Photomicrography; (*a*) Projection of the image on the plate; (*b*) Illumination of the object with transmitted and incident light (vertical illuminator).

Friday, Oct. 15.—Herr Dr. A. Köhler, Lecture on Photo-
10 to 11.30 a.m. micrography with Ultra-Violet Light,
11.30 to 1 p.m. Herr Dr. H. Siedentopf, Lecture on Ultra-Microscopy.

Saturday, Oct. 16.—Demonstration relating to the Lectures
10 a.m. to 1 p.m. delivered on the previous day.
(*a*) Photomicrography with Ultra-violet Light; (*b*) with Monochromatic Visible Light; (*c*) with Incident Light (Vertical Illuminator), for Metallography; (*d*) Ultra-microscopy of firm Colloids; (*e*) Ultra-microscopy of Colloidal Solutions; (*f*) Ultra-microscopy of Cells and Fibres.

In connection with the foregoing remark as to the neglect of microscopy as a definite science requiring study and teaching, I am glad to note the recent election of Mr. J. E. Barnard, F.R.M.S., to a Lectureship in Microscopy in the Bacteriological and Pathological Department at King's College, London, as an evidence of progress and enlightenment in this matter.

[Communications and inquries on Microscopical matters should be addressed to F. Shillington Scales, "Redcourt," Adams Road, Cambridge, Correspondents are requested not to send specimens to be named.]

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The Face of the Sky for August.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 4.24 and sets at 7.47; on the 31st he rises at 5.11 and sets at 6.48. Sunspots may usually be observed on the solar disc in spite of the declining solar activity. The positions of the Sun's axis, equator, and the heliographic longitude of the centre of the disc are shown in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
July 30 ..	10° 3′E	5° 43′	317° 2′
Aug. 4 ..	12° 3′E	6° 4′	250° 55′
,, 9 ..	13° 56′E	6° 23′	184° 48′
,, 14 ..	15° 44′E	6° 39′	118° 42′
,, 19 ..	17° 25′E	6° 52′	52° 37′
,, 24 ..	18° 58′E	7° 2′	346° 33′
,, 29 ..	20° 24′E	7° 10′	280° 29′

THE MOON:—

Date.	Phases.	H. M.
Aug. 1..	○ Full Moon	9 14 p.m.
,, 8..	☾ Last Quarter	0 10 p.m.
,, 15..	● New Moon	11 55 p.m.
,, 24..	☽ First Quarter	3 55 a.m.
,, 31..	○ Full Moon	5 8 a.m.
Aug 4..	Perigee.	4 0 a.m.
,, 19..	Apogee.	10 42 p.m.

OCCULTATIONS.—The following occultations are visible at Greenwich:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			P.M.		a m	
Aug. 6	ν Piscium ..	4·7	11.35	25°	12.23	278°
					p m.	
,, 29	37 Capricorni	5·9	10.50	53°	11 59	260°

THE PLANETS.—Mercury (August 1, R.A. 8h 32m; Dec. N. 20° 29′. August 31, R.A. 11h 57m; Dec. S. 0° 1′) is in superior conjunction with the Sun on the 4th. Towards the end of the month the planet is an evening star in Leo, setting at 7.24 p.m. on the 31st.

Venus (August 1, R.A. 10h 25m; Dec. N. 11° 28′. August 31, R.A. 12h 38m; Dec. S. 3° 33′) is an evening star in Leo, setting at 8.50 p.m. on the 1st and at 7.46 p m. on the 31st. As seen in the telescope, the planet appears gibbous, 0·87 of the disc being illuminated. Towards the end of the month the planet commences to be observable for a short time after sunset.

Mars (August 1, R.A. 0h 21m; Dec. S. 2° 59′. August 31, R.A. 0h 32m; Dec S. 2° 35′) rises on the 1st at 9.52 p.m. and on the 31st at 8.3 p.m. He is now becoming favourably placed for observation and increasing in brightness, as opposition takes place on the 24th of next month. The Southern hemisphere of Mars is inclined towards the Earth, thus the South polar cap is visible, but since the summer solstice of the Martian Southern hemisphere occurs on September 14, the polar cap appears small. On the evening of the 5th the planet appears in close proximity to the Moon, the planet being to the South. The apparent diameter of the planet is 20″ and is rapidly increasing as its distance from the Earth diminishes. The opposition of next month will be the most favourable since that of 1892.

Jupiter (August 1, R.A. 11h 6m; Dec. N. 6° 56′. August 31, R.A. 11h 29m; Dec. N. 4° 31′) is almost unobservable, as he is low down in the West at sunset. The planet sets on the 1st at 9.7 p.m. and on the 31st at 7.20 p.m. No satellite phenomenon is observable this month as the planet appears in too bright a portion of the sky.

Saturn (August 1, R.A. 1h 30m; Dec. N. 6° 38′. August 31, R.A. 1h 28m; Dec. N. 6° 19′) rises on the 1st at 10.12 p.m. and on the 31st at 8.14 p.m., thus he is becoming favourably placed for observation, especially as his declination is greater than for many years past. The ring, as seen in the telescope, appears fairly open; the Southern surface is visible and inclined to our line of vision at an angle of 13°. The ring can be seen in quite small telescopes of about 1¼ inches aperture if the objective gives fine definition with a magnifying power of about 60. The diameter of the major and minor axes of the outer ring are 44″ and 10″ respectively, whilst the diameter of the ball is 18″.

Uranus (August 15, R.A. 19h 17m; Dec. S. 22° 44′) is on the meridian about 10 p.m. near the middle of the month. The planet is situated about 2° South-East of the star π Sagittarii, and although rather low down is otherwise well placed for observation. He can just be discerned with the naked eye, and in the telescope he appears to shine with a greenish hue, due to his remarkable spectrum, which consists of broad dark bands. These bands may be seen in a Maclean spectroscope on a telescope of about 3 inches aperture.

Neptune (August 15, R.A. 7h 18m; Dec. N. 21° 32′) is unobservable, as he was in conjunction with the Sun last month.

METEORS.—The *Perseid* shower lasts nearly all the month, the Earth encountering the densest portion of the swarm about the 11th, the radiant then being near η Persei. The meteors are quick with yellowish streaks.

Mira (ο Ceti) is at maximum next month on the 7th, thus observations should be commenced both of its spectrum and brightness.

THE danger of explosion of mixtures of air and combustible dust is well known. Explosions of this character occur in flour mills and frequently in coal mines. Mixtures of air and aluminium powder are very liable to explosion. The combustion of aluminium powder produces a very high temperature. On this fact is based the process of autogenous welding of iron rails which is known as aluminothermy. Recently, in a factory near Nuremberg, where a metallic surface is given to paper by means of aluminium powder, the breaking of the globe of an enclosed arc lamp (Liliput) caused an explosion which killed two men and wounded several others.

IN a discussion on the Hawks and Owls of Victoria, reported in the *Victorian Naturalist*, Dr. Macgillivray related a number of interesting facts about different members of the groups which had come under his notice during many years' experiences in the back country. He maintained that the Wedge-tailed Eagle rather than being a nuisance to pastoralists was a benefit, as it was very destructive to rabbits. On one occasion he found the remains of no less than two hundred rabbits round one nest, besides which there were ten freshly killed ones. His experience was that only weakly lambs were attacked. The Goshawk was very destructive to small birds, while the Sparrow-hawk preferred domestic chickens. Owls, as a rule, fed largely on insects, but the Barn Owl was very destructive to rats, mice, and the smaller marsupials. The Black-cheeked Falcon was remarkable for its determination and courage, and he had observed it feeding on the small Shell Parrakeets.

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